SCIENCE

FRIDAY, FEBRUARY 22, 1889.

PRACTICAL ELECTRIC-RAILWAY PROPULSION.

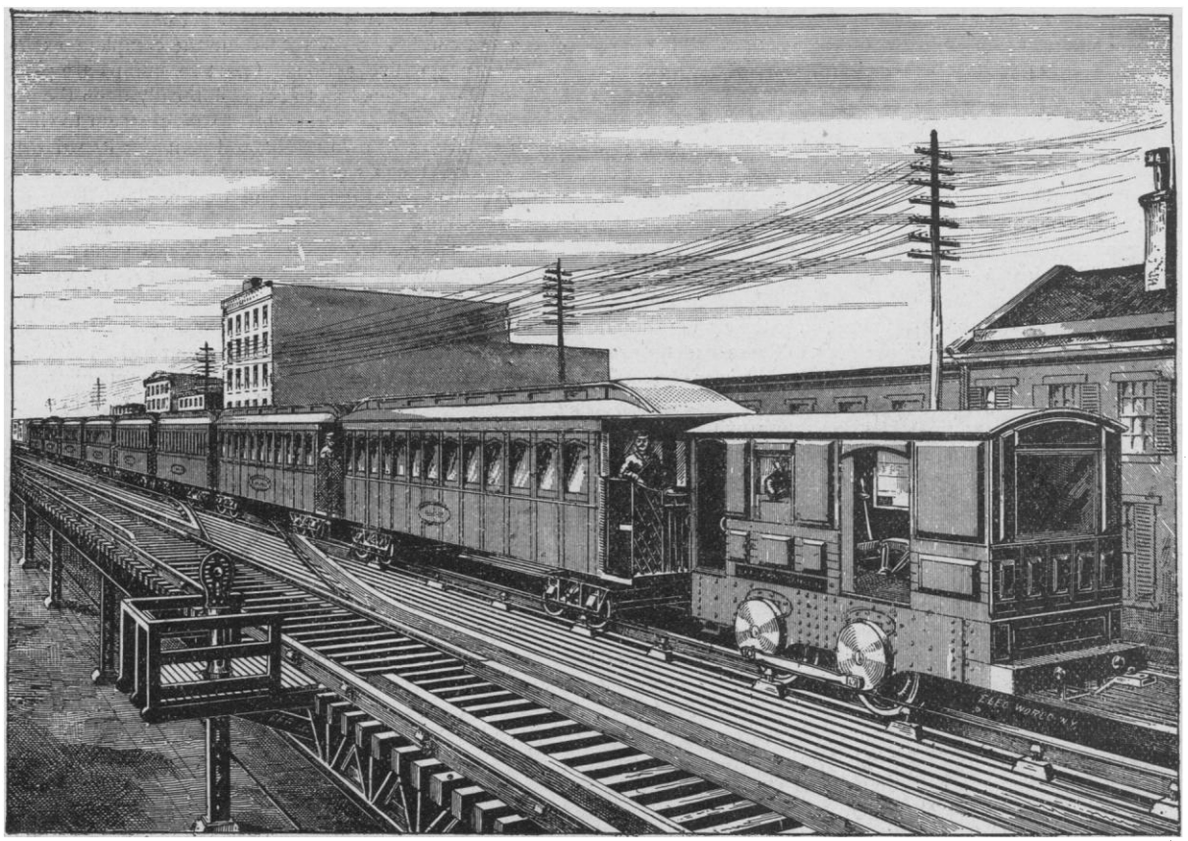
IT is a striking indication of the overcrowded surcharged state of modern life that events of extreme significance and momentous importance take place without exciting more than a ripple on the surface of its current, so rapid, deep, and vast it is.

Such an instance is depicted in the accompanying illustration, which is of the electric locomotor "Benjamin Franklin," with its eight-car train, now running upon the Ninth Avenue Elevated Railway in New York City.

With these perfectly intelligible and merely fortuitous differences, the service of the steam and electric train is identical.

What the "Franklin" has achieved in its experimental work may be briefly stated as follows: It has drawn eight empty cars — making, with the locomotor, 122 tons in train — up a gradient of nearly two per cent at 7½ miles per hour, developing, in so doing, over 120 horse-power; it has taken four cars up the same gradient, with the average load of passengers, or 70 tons in train, at 15½ miles per hour, more than two miles faster than the schedule speed of the steam-locomotives; it has maintained speed of 30 and 25 miles per hour with trains of two and three unloaded cars.

All this has been done without the slightest accident or delay of



DAFT ELECTRIC MOTOR AND TRAIN OF EIGHT CARS ON THE NEW YORK ELEVATED RAILWAY.

To be literally accurate, it should be said that the service is confined to certain hours of the day, that only three or four cars are used in it, and that passengers are only taken on at the termini; viz., Fourteenth and Fiftieth Street stations.

The reasons for these limitations are as follows: Since the locomotor has to be switched from one end of the train to the other at each terminus, only that portion of the day is available in which the headway of the steam-trains, among which it runs, affords sufficient time for the operation. In the many hundred miles that the "Franklin" has made, it has never delayed a steam-train or deranged their succession. The cause of not stopping at intermediate stations is, that, as the locomotor has at present no means of utilizing the air-brakes, — though this lack is being provided for, — the necessary reduction of speed near every station, to permit of the trains being brought to rest by hand-brakes, would so trench upon the time needed for switching, at each terminus, as to endanger delaying steam-trains, or sacrificing trips to avoid so doing.

any kind, and with every indication of the locomotor still being well within its ultimate capacity. For facility, certainty, and promptness of manipulation, nothing more could be asked for.

Such a chapter of success as this, quite apart from its technical and commercial significance, ought surely to have been fittingly recognized. The first grand scale electric locomotor in the world's history, and the first ever brought into direct competition with steam-locomotives, after doing all that they do, and triumphantly complying with every imposed condition, elicits little more from the technical press than a few perfunctory allusions alike distinguished for incompleteness and inaccuracy.

The gist of one notice was dissatisfaction that the "Franklin," in spite of its complete success, was not something else than what it is, and an inane caution, that, notwithstanding its ready disposal of every suggested test, and easy rivalling of the steam-locomotives in all respects, it would be advisable to lay this practical, actual entity on the shelf, and wait for the possibility of something better turning

up, in shape of the inchoate *eidolon-fori* of some nameless dreamy inventor.

Technical journalism, in the field of electrical power at least, would seem to be at a low ebb in New York.

As for the current-generating plant and conductive system, they, as well as the "Franklin," are entirely of the Daft design. The former is on Fifteenth Street, about midway between Sixth and Seventh Avenues, and wires of suitable size convey the current to and fro between the stationary plant and the track-conductors. A steam-engine of 250 horse-power drives four dynamo-generators of 50 horse-power each.

The conductor is a copper rod, five-eighths of an inch in diameter, sustained by insulators attached to the guard-timbers alongside the track. Elastic copper "brushes" pressing against and sliding along this rod convey the current to the electro-motive mechanism, which it traverses, causing revolution by its passage, and completes its circuit through the wheels and track-rails.

Time and space will not admit of an analysis of the inherent and incidental economy of electric propulsion; but "he who runs may read," whether or no the preference lies with the light, comparatively noiseless, cleanly electro-locomotor, devoid of steam, smoke, cinder, and hot *jets d'eau*, or the ponderous, clamorous, steam-locomotive, wasteful of fuel, destructive of road-bed, and inherently hampered by nuisances from which its electric rival is absolutely free. X.

THE WORTHINGTON INDEPENDENT CONDENSER.

THAT the practical results attained by condensing-engines should approximate to those that theory indicates, it is important that the condensing-apparatus employed should be the most efficient possible; that it should maintain the highest vacuum, with the least cost of production; that it should be regular and reliable in action, and simple in construction; and that its application to the engine should be unaccompanied by any risk of accident. These exacting requirements, it is claimed, are fully met by the condenser shown in the accompanying illustrations.

Exhaust-steam from an engine enters a vacuum with a velocity of about 1,900 feet per second; and water, under atmospheric pressure, with a velocity of 47 feet a second. Excepting the machine herein described, it may be said that in all forms of jet-condensers operated by air-pumps, the injection-water and the water from the steam fall to the bottom of the condensing-chamber, come to a standstill before entering the pump, and consequently lose the valuable momentum acquired when entering the vacuous space. In this condenser, however, the construction and arrangement are such that the momentum of the steam and water is conserved, and this force is utilized to assist the pump in its work.

By a careful adaptation of the injector principle, it is possible, in an experimental way, to produce a vacuum, of low degree however, without the use of a pump at all, — simply by the momentum given to a flow of water by the impact of the exhaust-steam at the point of condensation. A condenser dependent upon this alone is not practical, because of its small range of action, the inferior vacuum it obtains, and the low temperature of the discharge-water. A change of the amount of steam to be condensed disturbs the theoretical conditions, and renders this kind of apparatus too unreliable in practice. It is plain that the addition of a duplex pump to the discharge of such an ejector condenser perfects and governs its action. As the momentum of the water is not impaired, the highest economy of operation is reached.

In this condenser, the air set free by the condensation of the steam is intermingled with the water. The pump has the same regularity of motion that is characteristic of Worthington pumping machinery; in fact, it acts as a water-pump, although the water is aerated. There is here a great distinction between this condenser pumping aerated water, and an air-pump pumping air and water unmixed. In the latter case, the air-pump has a varying and irregular duty to perform, and the inevitable result is an irregular and slamming movement.

The lower of the accompanying illustrations is a longitudinal section of one side of the condenser-pump, and also a section of the condenser-cone, spray-pipe, exhaust-elbow, and injection-elbow. *A* is the vapor-opening, to which is connected the pipe that conducts to the apparatus the steam or vapor that is to be condensed, and in which a vacuum is to be made and maintained. The injection-water used to produce the condensation of the steam or vapor is conveyed by a proper pipe attached to the injection-opening at *B*. *C* is the spray-pipe, and has at its lower extremity a number of vertical slits, through which the water of injection passes, and becomes spread out into thin sheets. The spray-cone *D*, by means of its serrated surface, breaks the water passing over it into fine spray, and thus insures a rapid and thorough intermixture with the steam. This spray-cone is adjustable by means of the handle *E*. The piston-pump *G* is of the well-known Worthington type; built, however, with especial attention to the requirements of the service which is now being considered. *H H* shows the position of the induction, and *I I* of the eduction valves. *J* is the discharge-opening. At *K* may be seen the steam or engine end of the machine, the standard form used on all Worthington steam-pumps. The steam-valve is an ordinary slide-valve, working upon a flat surface over ports or openings. The motion of this valve is produced by a vibrating arm, *L*, which swings through the whole length of the stroke with long and easy leverage.

This valve motion is a prominent feature of the Worthington independent condenser. To it is due the complete exemption from noise or concussive action. The two pumps are placed side by side, and so combined as to act reciprocally upon the steam-valves of each other. One piston acts to give steam to the other, after which it finishes its own stroke and waits for its valve to be acted upon before it can renew its motion. This pause allows all the water-valves to seat quietly, and removes every thing like harshness of motion.

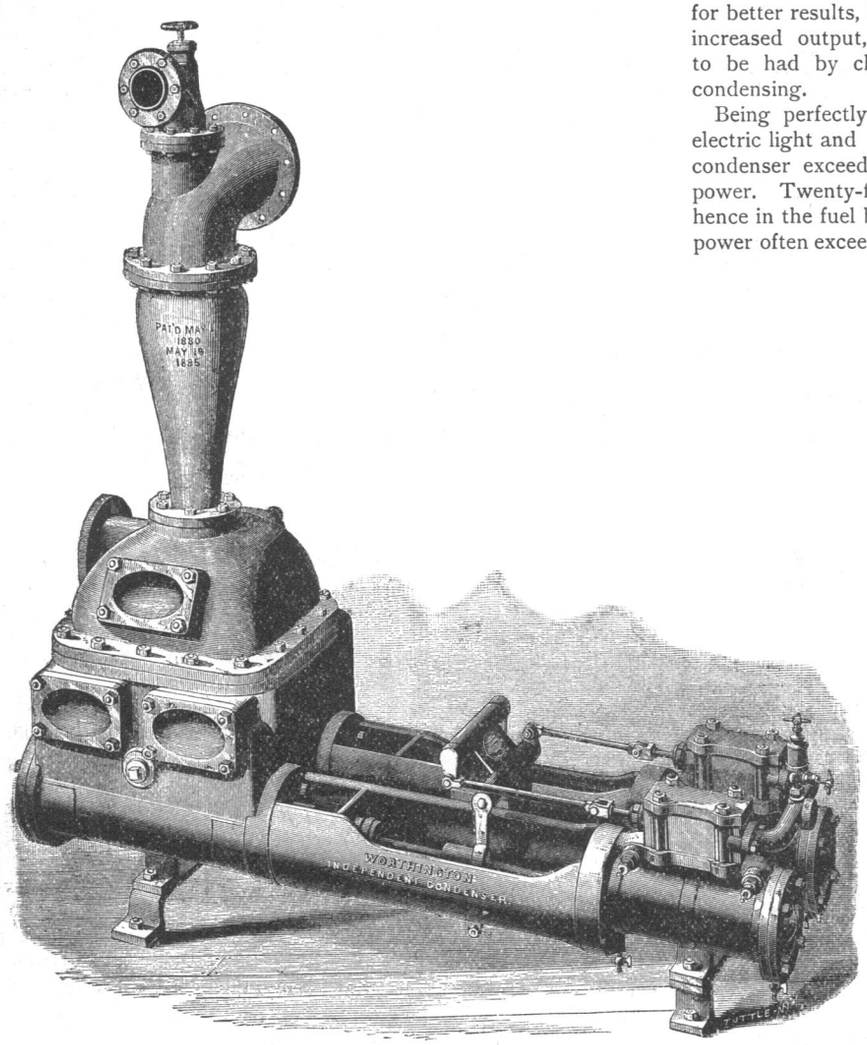
As one or the other of the steam-valves must always be open, there can be no dead point. The pump is therefore always ready to start when steam is admitted, and is managed by the simple opening and shutting of the throttle-valve.

The operation of the condensing-apparatus is as follows: Steam being admitted to the cylinders *K*, so as to set the pump in motion, a vacuum is formed in the condenser, the engine-cylinder, the connecting exhaust-pipe, and the injection-pipe. This causes the injection-water to enter through the injection-pipe attached at *B*, and spray-pipe *C*, into the condenser-cone *F*. The main engine being then started, the exhaust-steam enters through the exhaust-pipe at *A*, and, coming into contact with the cold water, is rapidly condensed. The velocity of the steam is communicated to the water, and the whole passes through the cone *F* into the pump *G* at a high velocity, carrying with it, in a thoroughly commingled condition, all the air or uncondensable vapor which enters the condenser with the steam. The mingled air and water are discharged by the pump through the valves and pipe at *J*, before sufficient time or space has been allowed for separation to occur.

It will be seen that the zone in which the condensation takes place is small, and the rapid effect is due only to the immense surface exposed by the spraying water. In case the water accumulates in the condenser-cone *F*, either by reason of an increased supply or by a sluggishness or even stoppage of the pump, as soon as the level of the water reaches the spray-pipe and the spray becomes submerged, the vast surface is reduced to a minimum, only a small annular ring being exposed to the steam from the main engine. The vacuum is immediately broken, and the exhaust-steam escapes by blowing through the injection-pipe and through the valves of the pump, and out the discharge-pipe at *J*, forcing the water ahead of it: consequently flooding does not occur.

These condensers have been constructed from those of a very small size up to those of enormous power. Two, which are probably the largest independent condensers in the world, are now applied to an engine of 8,000 horse-power, the injection-water of which amounts to 15,000 gallons a minute, or what is equivalent to about 20,000,000 gallons a day. Many of them are in use in connection with stationary steam-engines, and with marine engines on boats running in fresh water. The Worthington condenser is also used in connection with surface condensers on sea-going steamers, where it has a field of usefulness that is at once apparent to those who will but consider its functions. It performs the duty of two distinct pumps, — the air-pump and the circulating pump. It

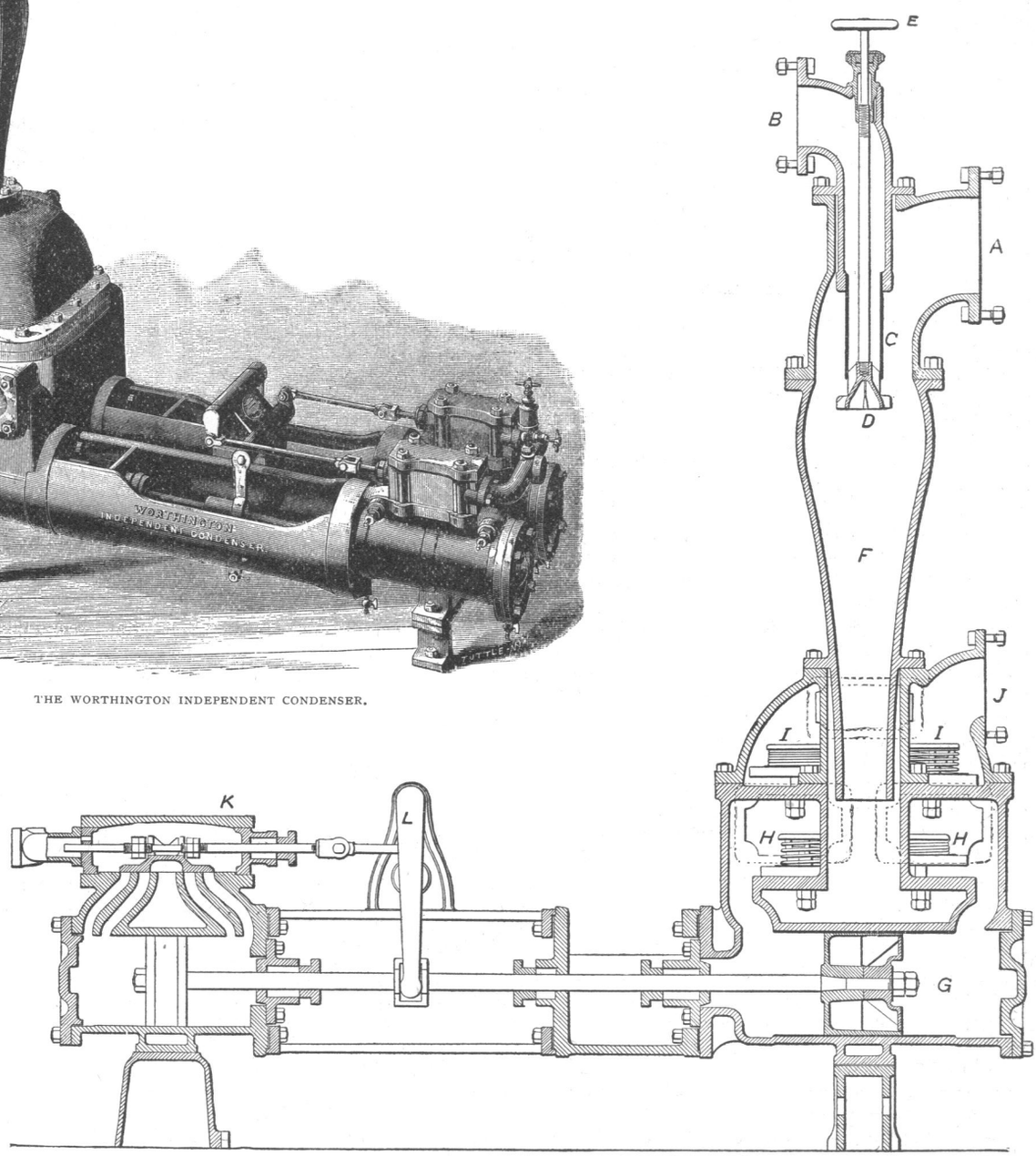
produces a high vacuum, and causes a forced or positive movement of the cooling-water. By its use, derangement of the surface-condenser does not deprive the engine of the vacuum, as the independent condenser can be used as a jet-condenser for the time being. The fact that one pump is dispensed with, should, in itself, commend the arrangement to the attention of engineers.



THE WORTHINGTON INDEPENDENT CONDENSER.

It is also a valuable adjunct to electric-lighting plants. Many of the plants that were erected during the early period of the history of electric lighting, were located indiscriminately. The boilers and engines were not the most economical, but answered well for a time. Those companies that were fortunate enough to find themselves adjacent to water-supply, when they began to look around for better results, have not waited long to avail themselves of the increased output, or the corresponding saving in fuel, that is to be had by changing the engines from non-condensing to condensing.

Being perfectly adapted to high-speed dynamo-engines, many electric light and power companies have found this independent condenser exceedingly valuable in connection with their steam-power. Twenty-five per cent saving in steam-consumption, and hence in the fuel burned, is frequently obtained. The increase in power often exceeds thirty per cent. In one of the above cases the gain is used to save steam, and in another to increase the output of power with same consumption of steam, and hence same fuel burned. There is a medium between these methods, and fuel can be saved and also power gained up to a sum total equal to the value of the twelve pounds per square inch made available by the



SECTIONAL VIEW OF THE WORTHINGTON INDEPENDENT CONDENSER.

vacuum. The independent condenser is also used in connection with fire-pumps, mine-pumps, and water-works pumping-engines, as well as with vacuum pans and other evaporating apparatus. They are made by Henry R. Worthington of this city.

THE DEVELOPMENT OF THE POTTERY INDUSTRY OF THE UNITED STATES.

MR. WILLIAM C. DAY, in the recent issue of the "Report on the Mineral Resources of the United States," traces the history of the pottery industry, which has of late become of considerable importance.

The first pottery established in the United States was in New York City, in its earliest days, when under Dutch rule. It was situated near the North River, above the present Chambers Street, the locality being at that time well out of town, in the country. More than a century ago, perhaps, a small pottery was established in Trenton, N.J., by some Frenchmen. Here porcelain, similar to what is now known as French china, was made, and it is said that the goods were very creditable. This establishment existed for some years, but it attained no great importance. At Philadelphia there was a similar pottery venture, also making porcelain or china wares, which are well spoken of for quality. This enterprise was sustained for a number of years, but failed to reach a permanent existence.

There were other attempts to establish potteries in various parts of the country from time to time, and the only one which seems to have given the greatest concern to English manufacturers was one established in South Carolina. This was contemporary with the great Josiah Wedgwood, who has been called the father of the pottery industry in Great Britain, from the fact that he made great improvements in the quality of earthenware, which gave a very great impetus to the business in England. This South Carolina pottery proved quite alarming to Wedgwood, as he feared that it might become a dangerous competitor in supplying the earthenware markets of the colonies: he therefore petitioned Parliament that the manufacture of such goods be prohibited. He seemed to think, that, with the excellent materials found in South Carolina for making earthenware, the industry would become a successful one. His fears, however, proved groundless, as the unequal struggle was of short duration.

One or two pottery enterprises, inaugurated within the past forty years, making special articles of white crockery-ware rather than a general assortment, maintained their existence only, and cannot be termed successful.

The term "pottery industry," as understood at the present time, does not include the many little potteries scattered all over the United States, making stone-ware jugs, pie-plates, drain tile, yellow crockery, etc., and which employ from six to twenty men each. These little establishments made the cheapest and commonest class of pottery products, with which foreign competition was powerless. Owing to the very low-priced class of such wares, the expenses of their importation bore so large a proportion to their cost at the foreign potteries, that competition was out of the question. In fact, in many cases the crates in which the goods were packed, and the inland transportation charges, equalled the original cost of the goods themselves. The pottery industry, as now spoken of, had therefore practically no existence in the United States in 1861, the several hundreds of so-called potteries in this country which statistics show then existed being all of the class above referred to. The Morrill Tariff Bill, and the increase of duty from 24 to 35 per cent, and the subsequent increase to 40 per cent, did not act as inducements towards the establishment of any new enterprise. In 1863 the rapidly increasing premium on gold offered the necessary inducement, and several pottery enterprises were inaugurated. These manufactured at first the commonest class of crockery-ware for domestic uses; but as experience gave confidence, and the wares gradually found favor, better grades were made, until the standard of the china-ware used by the millions of American citizens, and manufactured in this country, is recognized as equal to that made anywhere. It is true that there are several potteries in the United States who make more or less of very fine art pieces, which are forcing recognition on account of their superior excellence; but the stability of the pottery industry rests upon the fact that it supplies the wants of the people for fine and common crockery for domestic uses, of which we in this country manufacture about 60 per cent. The American potter does not claim to be the peer of his foreign competitor in art productions, but he does claim to equal any foreign manufacturer in the class of china which he produces for the American people. To-day the English potter is copying American shapes, designs, and styles of decorations. How different is this state of affairs from that which existed a few years ago, when the American potter depended upon foreign ideas for his shapes and designs! With the development of the manufacturing process, talent for designing shapes and patterns or styles of decoration has likewise progressed, until we have made our own American shapes and designs, which foreigners have been compelled to copy and adopt in order to find a market for their wares in the United States.

This country still takes about 40 per cent of the total crockery-ware exported by England. This is about the proportion that has been maintained for many years, thus showing that the American potter has increased his output in keeping with the increased consumption of the country.

In regard to the present prices of pottery, it may be said that the consumer can now obtain for two dollars and a half what in 1861 would have cost four dollars.

The pottery industry gives directly employment to about ten thousand people, to whom wages amounting annually to four million dollars are paid; this amount being nearly 50 per cent of the total value of the output of the potteries. In addition to these, there are many thousand more employed in the preparation of the materials for the potter's use, such as mining the clays, quartz, and felspar, and grinding and washing the materials. To these people nearly as much more in wages is paid; in fact, a careful estimate shows that 90 per cent of the cost of manufacturing pottery is paid for labor in one form or another.

The decorating branch of this industry is one of its most interesting features, and one in which great advances have been made in late years. It gives employment of a light, interesting, and elevating character to many young people, both male and female. The growth of this branch has been wonderful, and has made the demand for beautiful decoration, both simple and elaborate, very general, and far more wide-spread throughout the country than ever before. Formerly beautiful decoration was to be found only in costly French and English wares, and the consumption was consequently limited to the wealthiest classes: now beautiful decorated wares are found in almost any household, where they have been obtained at prices which would have been considered impossible a few years ago, and which have reduced very greatly the cost for French and English decorated products, and to a very great extent have enabled American decorated ware to supersede the foreign.

HEALTH MATTERS.

YELLOW-FEVER. — Dr. George M. Sternberg, U.S.A., has been relieved from duty at Baltimore, and is, by direction of the President, in pursuance of the authority contained in the provisions of the Act of Congress approved March 3, 1887, "making appropriations for sundry civil expenses of the government," etc., relating to the methods of preventing the spread of epidemic diseases, to proceed to the Island of Cuba for the purpose named in the letter of the President addressed to the secretary of war, April 17, 1888, and upon completion of this duty to return to his proper station and submit his report to the President. Dr. Sternberg is at the present time at the Hoagland Laboratory, Brooklyn, of which he is general director, engaged in making his preparations for his proposed trip to Cuba to pursue his investigation in yellow-fever. He expects to leave for Havana during the latter part of March.

LEGAL REGULATION OF MEDICAL PRACTICE. — The laws of West Virginia require that every physician in that State must have a certificate from the State Board of Health to entitle him to prac-

tise. An irregular practitioner attempted to evade this legal requirement, and was prosecuted. The case, being decided adverse to him, was finally carried to the Supreme Court of the United States on the ground that the act was invalid. This court sustained the lower courts in the following opinion: "The power of the State to provide for the general welfare of its people authorizes it to prescribe all such regulations as may be necessary to secure the people against the consequences of ignorance and incapacity as well as deception and fraud. One means to secure this end is the method adopted by the State of West Virginia. If the means adopted are appropriate to the calling or profession, and obtainable by reasonable study and application, no objection to their validity can be raised."

CONTAGIOUSNESS OF CONSUMPTION. — Mr. MacMullen, in the *Australasian Medical Gazette*, calls attention to the danger to which healthy travellers are subjected by consumptives. To illustrate this danger, he narrates a case in which a healthy man, on the voyage from London to Australia, was placed in the same stateroom with a consumptive in search of health. Now that consumption is regarded as a communicable disease, there is no longer excuse for this commingling of well and sick in such confined quarters as a ship's stateroom. Steps should be taken by the owners of steamships and other vessels to separate those who are so unfortunate as to have consumption, from those that are healthy, to the degree, at least, that the unsuspecting traveller would not be required to breathe the air impoverished and possibly infected by an invalid suffering from pulmonary consumption.

DOCTORS ADVERTISING. — The Board of Health of Illinois a few months ago revoked the license of H. G. Wildman, a physician, the chief charge being that he had overstepped the ethics of the profession by advertising his success and skill in newspapers. Dr. Wildman then appealed the case to Gov. Oglesby, and he rendered his opinion a few days since, reversing the decision of the Board of Health, and claiming that a physician should not be debarred from practice because he advertises what he can do and has done. Dr. Wildman expends over forty thousand dollars yearly in advertising in papers all over the Union, and several of the Illinois papers went on his bond in the action.

PUBLIC MEDICAL LIBRARIES. — In the proceedings at the reception given to Dr. Oliver Wendell Holmes, says the *New York Medical Record*, on the occasion of his presenting his library to the Boston Medical Library Association, Dr. R. M. Hodges, president of the association, gave some facts regarding the public medical libraries of this country. "First," he said, "in point of time, is the library of the Pennsylvania Hospital, founded in 1760; second, that of the College of Physicians in Philadelphia, founded in 1788; third, the New York Hospital Library, in 1796, etc. Of course, the library of the surgeon-general's office has surpassed in size all these, having a large annual appropriation and a magnificent librarian. Next in rank comes the library of the College of Physicians; next, that of the Academy of Physicians; and our library comes fourth in rank. After that come the Medical Department of the Public Library of Boston, and the New York Hospital Library. In other words, although the youngest of these seven libraries, ours has already passed three of them. We have nearly twenty thousand volumes."

DANGER IN THE POSTAGE-STAMP. — The *Sanitary News* calls attention to the fact that a postage-stamp may in various ways convey contagion. One of the simplest and most plausible is that in which a postage-stamp, partially attached to a letter to pay return postage, is sent by a person infected with some disease to another person. The disease is transferred, in the first place, to the adhesive stamp through the saliva, and in being attached to the letter by the receiver the poison may be transmitted to him in turn through the saliva. Another cause may be the infection of the stamp with disease germs. The stamp, having been exposed in a room where a diseased person lies, may become slightly moistened, and thus retain the germ. That this is true can be proved very simply by a microscopical examination. We often see a person holding change for a moment in the mouth, probably not knowing that investigation has shown that disease germs can be carried by money. If one could see through what hands the money has passed, he would hesitate before using such a third hand. Silver money is as bad as paper money; but, while many would hesitate to hold a dirty bank-note in their mouth, they think that a silver piece, because bright, is apparently clean.

SANITARY PLUMBING. — In speaking of the effects of sanitary plumbing, the *Sanitary News* says, "Dr. A. R. Carter, of the health department of Baltimore, has published some interesting statistics in regard to the effects of sanitary plumbing. He says that during a period of fifty-four years, from 1830 to 1883 inclusive, there were in that city 12,197 deaths from scarlet-fever, being an average of 226. In the last of those years there were 334 deaths. But the city council then passed an ordinance regulating plumbing, and in the years since, there has been a remarkable decrease in the mortality from scarlet-fever. In 1884 there were 104 deaths; in 1885, 67; in 1886, 32; and in 1887, 36; making a yearly average of 60, but with a plain tendency to decrease. The yearly average of deaths from diphtheria has in the same way diminished from 469 to 234." This kind of reasoning is, in our judgment, very fallacious. If the diminution of diphtheria in Baltimore is to be attributed solely to the improvement in plumbing, why did not the same result take place in New York and Brooklyn, where the improvement in plumbing has been most marked since 1882? In that year in New York there were 1,009 deaths from diphtheria; in 1884, 1,090; 1885, 1,325; 1886, 1,727; 1887, 2,167. In Brooklyn in 1883, 409 deaths occurred from this disease; in 1884, 385; 1885, 519; 1886, 782; and in 1888, 984. So far as scarlet-fever is concerned, the statistics of Brooklyn show no such marked difference in the various years as could be attributed to the plumbing. Thus in 1883 there were 505 deaths from this disease; in 1884, 218; 1885, 363; 1886, 340; and in 1888, 475. In New York there was a notable decline from 2,066 deaths in 1882, to 744 in 1883, which could not be attributed to improvements in plumbing. Since that time the number of deaths has not been as high, but the diminution cannot, we think, be traced to the better plumbing. We do not wish to be understood as disbelieving in the value to life and health of good plumbing, — on the contrary, we regard it as one of the most important factors in the preservation of health, — but we do not think it the only factor, and believe it to be a mistake to attribute the reduction of contagious disease in any small series of years to a single cause.

ELECTRICAL NEWS.

Hertz's Researches on Electric Oscillations.[1]

AFTER proving the existence of displacement currents in dielectrics, Hertz turned his attention to the propagation of waves in wires. To investigate this phenomenon, he used the apparatus shown in Fig. 9 (Fig. 11 in article). Here the primary circuit consisted of the two brass plates AA', connected by a conducting wire in which was an air-space. The secondary used was either B or C, a rectangle and circle of wire respectively, the periods of which were equal to that of the primary circuit, — about .000000014 of a second. The conducting plate P was placed behind and close to A, and a wire was taken from it in the direction shown, passed through a window, and at a distance of 60 metres was buried in the ground. Now, when the induction-coil is working, and oscillations occur in the primary circuit, disturbances are caused in the circuit Pmn, because of the induction of A upon P; and the period of this disturbance is of course equal to that of the primary. If the wire mn were short, there would be danger of disturbances from reflected waves, but 60 metres was found to be a sufficient length to obviate this.

When electrical waves pass through the wire, we should find loops and nodes, as in any other form of oscillation. To test this, secondary circuits whose periods were approximately that of the primary were brought close to the wire, and were moved along it, the result being noticed at different distances. As the secondary passed along, points of maximum and minimum effect were observed at regular intervals. The results are interesting. In the first place, the distances of minimum effect were — 0.2 metres,

[1] Continued from No. 314.

2.3 metres, 5.1 metres, and 8 metres; and in another experiment, —.1 metres, 2.8 metres, and 5.5 metres. The half wave-length, then, cannot be far from 2.8 metres, which would give, taking the period as .000000014 of a second, a velocity of propagation of 200,000 kilometres a second, — a result which lies between Fizeau and Gounelle's values of 100,000 kilometres for iron and 180,000 kilometres for copper, and Siemens's results, which gave from 200,000 to 260,000 kilometres per second for the volocity in iron wire. Another important point is, that, if the copper wire be replaced by one of different metal, the nodal points remain fixed, — that is, the velocity does not change, — and the same is true when the diameter of the wire is changed. This result is striking,

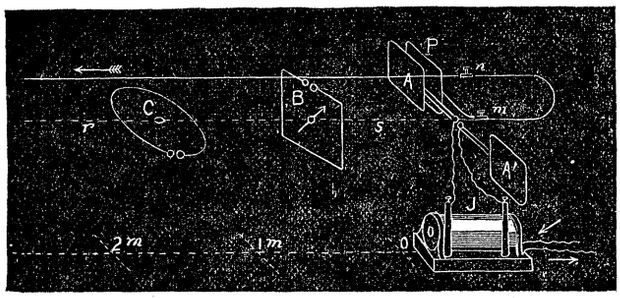


FIG. 9.

especially as showing that at such short periods the magnetic properties of iron wire have very little effect on the phenomenon.

Now, it is evident that a secondary circuit, such as *B*, Fig. 9 (Fig. 11 in paper), is subjected to two actions, — the action of the current in *mn*, and the direct action of the primary. If we obtain for any position of *B* a certain result, due to the combined action, and if, keeping the direction the same, we shift *B* along the wire a distance corresponding to one wave-length, then, provided the direct disturbance travelled with the same velocity as that along the wire, we should have a result of the same character as at first: if the actions were primarily in the same direction, they would still be so; if they at first opposed, they would still oppose one another. If, however, the actions travelled with un-

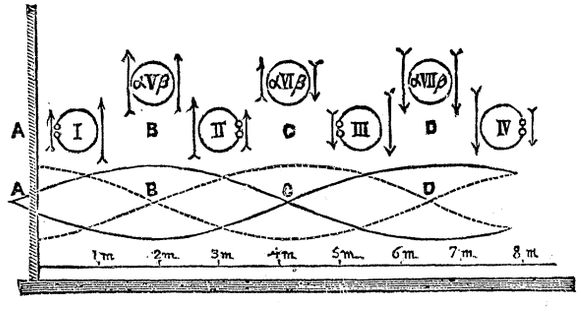


FIG. 10.

equal velocities, they would change their relative directions as the secondary was shifted along the wire, — slowly if the velocities were nearly alike, faster if they differed considerably. This is the result which Hertz obtained; the change of sign taking place, when the observations were at a considerable distance from the primary, in a distance of 7.5 metres, — a result which would give for the velocity in air a value equal to that in the wire multiplied by the ratio of 7.5 to 7.5 — 2.8, or 320,000 kilometres per second. Considering the very rough methods of experiment, this agrees very well with the velocity of light, which is approximately 300,000 kilometres per second.

But in this experiment a very important fact was developed. While the change of sign took place in a distance of 7.5 metres at points considerably removed from the primary, yet near the primary the change of sign was in a much shorter distance. Now, we have seen that near the primary the electro-static effects are of the greater importance, while at a distance from it the electro-dynamic actions can alone be considered. It would seem, then, that electro-static actions are propagated with greater velocity than electro-magnetic. It is hard to say from Hertz's results whether the velocity is infinite, since at a distance of 2.8 metres — the half-length of a wave on the wire — the magnetic effects are already of considerable importance. Still it seems fairly well proved that static and magnetic actions are propagated with different velocities, the latter being approximately that of light.

After this experiment, Hertz attempted to obtain evidences of the reflection of electro-magnetic waves from conducting surfaces. To do this, he placed the apparatus in a room whose dimensions were 15 metres in length, by 14 metres in width, by 6 metres high. There was a row of iron columns in the room, which cut off part of the available space, so that the width that could be utilized was reduced to 8.5 metres. All of the gas-fixtures having been removed, one wall of the room was prepared as a reflector by hanging on it a sheet of zinc, which was carefully attached to the gas-pipes and water-pipes. The primary circuit was arranged in a vertical position; the secondary was fitted so it could be moved into any position, this being usually accomplished by hand, although the body of the observer exerted a slight influence on the results. On placing the secondary in different positions between the primary circuit and the wall, results were obtained which are shown in Fig. 10 (Fig. 12 in article). With the secondary in the positions *I*, *II*, *III*, and *IV*, at distances from the wall shown by the scale, the strongest sparks were obtained when the air-space was in the position shown. At *V*, *VI*, and *VII* the same sparks occurred with the air-space at either side. This can be accounted for by supposing the waves to be those shown in the figure, the vibrations from the primary being reflected from the wall. Determining the length of the wave in this way, and assuming that they travel with the velocity of light, we obtain a period of .000000015 5 for the oscillations, instead of the .000000014 calculated from the dimensions of the circuit.

Such, in brief, are the most important of the results obtained by Hertz. He has developed a new experimental method, which in his own hands, and those of a number of physicists who are without doubt working now on the subject, will greatly extend our knowledge of what takes place in the vicinity of varying electric currents, and which will modify our views on the nature of electric actions. So far Hertz has shown that oscillations of short period can be practically obtained and experimented upon, and he has developed a method of investigation by means of a secondary circuit of a period equal to that of the vibration. He has shown, that, of the electro-static and electro-magnetic phenomena that accompany an oscillation, the former is of great importance near the oscillating current, but rapidly die away as the distance increases. He has shown that dielectrics have magnetic effects when placed near a conductor carrying an oscillating current, thus making more than probable Maxwell's hypothesis of "electric displacement." The velocity of a wave along a wire was determined, and from this the velocity of the electro-magnetic and electro-static waves in air were experimented upon. The former was found to be approximately that of light; the latter was much greater, but it was not possible to determine whether it was infinite. Lastly, electro-magnetic waves were reflected from a conducting surface, and their wave-length determined by the interference of the direct and reflected waves.

Hertz's work has put Maxwell's electro-magnetic theory of light on a firm basis, and has added experimental evidence to what was, after all, only an hypothesis.

ELECTRICITY AND LIGHT. — At a meeting of the Berlin Physical Society, Dec. 14, 1888, Professor von Helmholtz, the president, gave an account of a paper by Professor Hertz, which he had communicated the day before to the Berlin Academy. It contained a description of further experiments on electro-dynamic waves, and their analogy with waves of light. Weak induction discharges between small metallic cylinders with rounded ends were employed, and a similar apparatus for the detection of the electro-dynamic waves. The action was not propagated more than 2 or 3 metres through space; when it fell on a metallic surface, it was reflected, interference phenomena were observed, and from these the length

of half a wave was found to be 30 centimetres. When a metallic parabolic mirror, 1 metre across its opening, was placed behind the apparatus used to produce the discharge, the action was propagated to a distance of 8 metres; and the action was greatly increased when a second concave mirror was placed behind the receiving apparatus. When a conductor was interposed, the action ceased, while non-conductors allowed the waves to pass. By interposing perforated metallic screens, it was found that the waves are propagated in straight lines; the waves passed through a dry wooden partition. Polarization of the waves could be determined in several ways. When the receiver was placed at right angles to the apparatus producing the waves, no action between them could be detected, the vertically produced waves not being picked up by the horizontally placed receiver. When the two pieces of apparatus were placed parallel to each other, and a wooden cube, with a number of insulated metallic wire rings wrapped round it, was placed in the path of the electro-dynamic waves, it produced the same effect as does a tourmaline plate on polarized light. When the wires were vertical, — that is to say, parallel to the exciting apparatus, — the action was not propagated through the cube; but it was, on the other hand, when the wires were horizontal. When the receiver with its mirror was placed horizontally, so that it did not record any action as reaching it, and the wire arrangement described above was placed in the path of the waves, no change took place in the receiver when the wires on the cube were either vertical or horizontal; but the receiver was affected when the wires were placed at an angle of 45°. The laws of reflection of electro-dynamic waves at metallic surfaces were found to be the same as those for the reflection of light at plane mirrors. Finally, Professor Hertz has determined the refraction which the waves undergo in a prism made of pitch, and finds that the refractive index of this substance for electric waves is 1.68. Dr. Ritter demonstrated by experiments the action of the ultra-violet rays of light on electric discharges in accordance with the experiments of Hertz, Wiedemann, and Eberts.

LIGHT MOTORS FOR AERONAUTIC EXPERIMENTS. — M. Trouvé has constructed several small and extremely light motors of the Gramme and Siemens type, in order to carry out some aeronautic experiments. One of these motors, while only weighing about three ounces, is capable of developing .026 brake horse-power. All the parts of the machine are of aluminum with the exception of the magnets. This motor, which could be contained in a box 1.2 inches each way, is able to lift itself twenty-five yards a second by means of a wire and a fixed support. A one-horse-power motor constructed on the same lines would weigh barely eight pounds. When furnished with a light screw, and attached to the arm of a balance, the motor is able to lift its whole weight, when connected with a source of electric energy equal to forty watts. In order to facilitate his experiments, M. Trouvé places his motor at one end of a long lever capable of a vertical and horizontal movement about its centre, the electrical connections being made with the motor through the lever and its supports.

IMPORTANT PATENT DECISION. — In England the court of appeals has just handed down its decision reversing the finding of the lower court in the Edison incandescent lamp patent case. The case had been decided against Edison, principally on the ground of insufficient specification. This last decision upholds the Edison patents, and puts the Edison Company in England in the same position that it enjoys in Germany, where the patents have been uniformly upheld.

NOTES AND NEWS.

THE American Association for the Advancement of Science will meet at Toronto, Aug. 27 to Sept. 3; the first general session to be held on Aug. 28; the council meeting, on the 27th.

— The thirteenth anniversary of the Johns Hopkins University will be commemorated on Friday, Feb. 22, 1889. The public exercises of the day will be held in the Mount Vernon Place Methodist Episcopal Church at eleven o'clock. The public are invited to attend, and no tickets of admission will be required. The exercises in the church will close before one o'clock. The trustees, faculty, alumni, students, and gentlemen personally invited, will assemble at the university at half-past ten o'clock, and proceed in a body to the church, where seats will be reserved for them. The alumni of the university will have a social gathering with a luncheon after the close of the exercises in the church. The physical laboratory will be thrown open from eight to ten o'clock in the evening to members of the university and their friends, and the chief instruments and pieces of apparatus will be shown to visitors. Professor Rowland will make an address to physicists in the hall of the physical laboratory at half past four o'clock, on "Modern Views with Respect to Electric Currents." Specials cards of admission will be required. Right Rev. Henry C. Potter, Bishop of New York, preached the annual sermon before the Christian Association of the university in St. Paul's Church (corner of Charles and Saratoga Streets) on Sunday, Feb. 17, at 8 P.M.: subject, "The Mastery and Mastering of Circumstances." All members of the university were invited to attend. The University Glee Club gave a concert in the Lyceum Theatre on Tuesday, Feb. 19, at 8 P.M.: tickets, fifty cents. The Athletic Association gave a gymnastic exhibition in the gymnasium on Thursday, Feb. 21, at 8 P.M. Tickets (fifty cents each) had to be obtained at the University Post-Office.

— At a meeting of the American Oriental Society, held at Philadelphia, October, 1888, Isaac H. Hall, Richard J. H. Gottheil, George F. Moore, Edward W. Hopkins, and Cyrus Adler were appointed a committee to obtain information respecting manuscripts that exist in America, written in the Oriental languages or connected with their study, with a view to the ultimate publication of a comprehensive catalogue of the same, in a worthy manner, and calculated to serve all the useful purposes of the Oriental catalogues of the great libraries of Europe. The manuscripts which are the subject of inquiry include all the ancient and modern languages and dialects of Asia, with those of Egypt and Ethiopia, whatever be the subject-matter of the manuscript, whatever be the character of the writing for elegance or negligence, whatever be the material upon which it is written, whatever be its state of preservation, or whatever be its length or size. The points of inquiry include the language of the manuscripts, if known; the style of writing, or the alphabet employed (as, if the manuscript be Arabic, whether in Cufic or Neskhi, etc.; if Turkish, whether in Greek, Arabic, or Armenian letters, etc.), and the material upon which written; the size and binding (or absence of binding); number of leaves, and other external particulars of the manuscript; or, if a roll, its dimensions, and the number and dimensions of its columns (of fragments, papyrus, etc., the mere dimensions); the history of the manuscript, as far as known, and how it came into its present hands; if the manuscript is in a public library, both its present catalogue marks, and information respecting any former labels, library marks, or notes of ownership (the latter, of course, are desired if the manuscript is in private hands); also the date of the manuscript, if known.

— The field-work of the irrigation survey of the arid region of the United States is being vigorously prosecuted in Colorado and New Mexico, notwithstanding many disadvantages arising from cold and stormy weather. From Colorado, Mr. W. D. Johnson, in charge, reports the completion of the Pueblo and Huerfano sheet in fifty-foot contours, and on a scale of two miles to the inch, and considerable work done on the Apishapa and Juniata sheets, all being in the Arkansas valley. Mr. Johnson's parties, living in tents, have experienced temperatures below zero, and encountered twenty inches of snow; but such attention has been given to the men, that, beyond a few frost-bites, no trouble has been experienced in prosecuting work on every day not actually stormy. Work in New Mexico on the Lower Rio Grande has been commenced; Mr. R. Henry Phillips, in charge, reporting the arrival of his party at El Paso, and the occupancy of points connecting this work with the base-line measured near Fort Bliss in 1878 by the United States Engineers.

—Mr. Edwin Chadwick, the pioneer of sanitary reform in England, and indeed throughout the world, will, on the anniversary of his ninetieth birthday, March 2, be presented with a congratulatory

address by the Association of Public Sanitary Inspectors of England, of which body he is president.

— The third volume of "Studies from the Laboratory of Physiological Chemistry of the Sheffield Scientific School of Yale University" has just been published, under the editorship of Professor R. H. Chittenden, Ph.D. It contains the following subjects: "Some Experiments on the Physiological Action of Uranium Salts;" "Elastin and the Elastose Bodies;" "The Influence of Urethan, Paraldehyde, Antipyrin, and Antifebrin on Proteid Metabolism;" "The Influence of Several New Therapeutic Agents on Amylolytic and Proteolytic Action;" "Casesses, Caseine Dyspeptone, and Caseine Peptone;" "Some Experiments on the Influence of Arsenic and Antimony on Glycogenic Function and Fatty Degeneration of the Liver;" "The Nature and Chemical Composition of the Myosin of Muscle Tissue;" "Myosinoses, and the Relative Absorption of Nickel and Cobalt."

— The trustees of the Johns Hopkins Hospital have decided to formally open the hospital on May 1, and they have confided its organization to President Gilman of the university. It is said that for one year, at least, President Gilman will reside in the hospital, and exercise a close personal supervision over its executive management.

— Dr. John Call Dalton, one of the foremost physiologists of the world, and a writer of one of the best text-books on physiology, died in New York City on Feb. 12, at the age of sixty-four years.

— The French Association for the Advancement of Science will meet in Paris, Aug. 8–15; and the Congress of Geography and Ethnography will meet there Aug. 5–12. As the great exposition will also be open during August, extra inducements are offered to American scientists visiting Paris this summer.

— The fifth volume of the "Transactions of the American Institute of Electrical Engineers" is now in the hands of the binder. Including the index of current electrical literature, it makes a volume of 638 pages, and is fully indexed. Hereafter the monthly numbers will be paged consecutively, and should be carefully preserved for binding by all who desire to preserve the complete files, as they will not be revised and issued as an annual, as has been done this year in the case of Vol. V. Temporary binders for filing the numbers as received will be furnished by the secretary at seventy-five cents each.

— We have received from Hon. F. G. Adams, secretary, the "Sixth Biennial Report of the Kansas State Historical Society." The number of volumes in the society's library at the present time is as follows: namely, 9,971 bound volumes, 30,353 unbound volumes, 7,981 bound newspaper files and volumes of periodicals; in all, 48,305 volumes. Of the newspaper volumes, 5,757 are of Kansas. The list and tables which the report contains show that there is being made up by this society, for the use of the people of Kansas, a library of history and reference, remarkable in its growth, and still more remarkable in the character and value of the materials which it contains. They show that the growth of the library and collections has steadily continued from year to year during the thirteen years of the society's existence, and that in that time there have been placed on the library shelves more than forty-eight thousand volumes of books, newspaper files, and pamphlets; and, in addition to these, this and former reports show a collection of manuscripts, pictures, statuary, relics, and objects of historical illustration of every kind and description almost countless in number.

— The American Institute of Electrical Engineers (5 Beekman Street, New York), in addition to the letters from the Institution of Civil Engineers and the Society of Arts, has received one from the Institution of Electrical Engineers of London, to the effect that the president and council of that institution, having been informed by Mr. W. H. Preece, one of its past presidents, that many of the members of the American Institute will be visiting the Paris Universal Exhibition this year, and will probably also visit London, will take pleasure in welcoming those gentlemen, and in doing all that is in their power to render their visit to England agreeable and instructive. Communications of the same tenor, addressed to the American societies of civil engineers, mechanical engineers, and mining engineers, led to the organization of an excursion, by which the members of those bodies were enabled to secure two special steamers, at the reduced rate of one hundred and ten dollars for the round trip to Liverpool. On account of the uncertainty as to proper accommodation in those steamers, and the early date of their departure (about June 1), the council of the American Institute does not deem it expedient for the electrical engineers to unite in the same arrangement, as the date fixed for the electrical conference at Paris (the latter part of August), together with the probability of the exhibition being in an incomplete condition, points to the desirability of fixing the date of departure about Aug. 1. Members who propose making the trip are, however, requested to notify the secretary as to the date of departure and return which would be most convenient for them; and, should it be found that a sufficient number agree approximately upon a date, an effort will be made to secure special rates. The regular excursion fare for first-class accommodations is one hundred and eighty dollars.

— In *The Microscope* for February, 1889, A. Clifford Mercer, M.D., describes a method of using with ease objectives of shortest working distance in the clinical study of bacteria. The working distance of homogeneous immersion objectives of short focus and great numerical aperture is little. In the clinical study of bacteria, sputa and other more or less fluid material are generally prepared on the under surface of cover-glasses, commonly, when not measured and assorted, so thick as to make examination with the above most suitable objectives impossible. To avoid this difficulty, Dr. Mercer dries and stains the material on the slide, drops homogeneous immersion fluid upon the preparation, and lowers the objective into the drop. Homogeneous fluid replaces both the balsam and the cover-glass with optical propriety. A twenty-fifth, which has been nearly useless over ordinary cover-glass preparations, is now used with gratifying freedom in manipulation over uncovered, but homogeneously immersed, slide preparations.

— The following is the list of the officers of the Kent Scientific Institute of Grand Rapids, Mich., for 1889: president, E. S. Holmes; vice-president, W. A. Gruson; recording secretary, C. W. Carman; corresponding secretary, E. S. Holmes; treasurer, C. A. Whittemore; director of the museum, W. A. Gruson; curator, C. W. Carman; librarian, E. L. Mosely; board of directors, Wright L. Coffinberry, W. A. Gruson, Samuel L. Fuller, E. S. Holmes, J. W. Jones, C. A. Whittemore; officers of the board, W. A. Gruson (chairman), E. S. Holmes (secretary), C. A. Whittemore (treasurer).

— The art schools of the Metropolitan Museum of Art have been established by the trustees of the Metropolitan Museum of Art, in order to furnish superior opportunities for thorough instruction in design, modelling, color, freehand, architectural, cabinet, and perspective drawing, chasing and hammered-metal work, carving in wood, painting on china, etc., especially to those who desire to acquire an artistic education applicable to industrial and commercial uses. Large, new, well lighted and ventilated rooms have been provided in a central position, with superior art material and instruction, and a liberal basis of admission. In order to offer all genuine students every facility in their work, a series of lectures have been added, the privilege of visiting the museum free of expense, prizes, diplomas, and opportunities for the sale of meritorious work; so that all may measure their progress by the degree of their industry and application. All payments are to be made in advance. Applicants for admission to the school must bring a letter of introduction from some resident of good standing. It is desirable that intending students should bring samples of their work to determine the degree of their proficiency. Those who follow the full course in each department receive diplomas upon passing a satisfactory examination at the close of the final term. The full courses are: — Drawing and painting, three seasons: 1st, Introductory class; 2d, "Antique" class; 3d, Life class. Sculpture, three seasons: 1st, In one of the drawing classes; 2d and 3d, In the modelling-room, with attendance at the anatomy lectures. Architecture, three seasons, the course to include architectural drawing, history and mathematics. It is intended that those who follow this course should be sufficiently advanced to pass the examinations of the

Paris Ecole des Beaux Arts. Diplomas will be issued to members of the normal, decoration, metal, wood-carving, and cabinet drawing-classes who have previously passed a season in one of the drawing-classes, and have shown satisfactory progress.

— A technical laboratory for special instruction in dyeing and bleaching, says *Nature*, has just been opened in connection with University College, Dundee. This technical portion of the chemical department consists of a completely fitted dye-house, a laboratory, and a museum for technical samples, more especially connected with the textile industries of the district. Practical instruction in the dye-house was begun by Professor Percy Frankland last week.

— It is well known that the aurora has a period of eleven years corresponding to that of terrestrial magnetism and of sunspots. It has recently been proved that the magnetical phenomena have a period of twenty-six days. This fact suggested to Mr. J. Liznar the plan of attempting to find a corresponding period in the frequency of the aurora. He subjected the hourly observations of the polar stations at Bossekop, Jan Mayen, and Fort Rae, in 1882–83, to an investigation, and found a very distinct period of this length, the maxima and minima of which corresponded exactly to those of the magnetic period. From this fact Mr. Liznar concludes that the connection between aurora and terrestrial magnetism is still closer than has been heretofore supposed.

— The tenth session of the International Congress of Anthropology and Prehistoric Archæology will meet in Paris Aug. 19–26. The programme, subject to additions, is as follows: (1) "The Erosion and Filling-up of Valleys and the Filling-up of Caves in their Relation to the Antiquity of Man;" (2) "The Periodicity of Glacial Phenomena;" (3) "Art and Industry in Caves, and the Value of Paleontological and Archæological Classification when applied to the Quaternary Epoch;" (4) "Chronological Relation between the Stone, Bronze, and Iron Ages;" (5) "Relations between the Civilizations of Hallstadt and the Other Danubian Stations and the Civilization of Mycenæ, Tirynthus, Issarlik, and the Caucasus;" (6) "A Critical Discussion of the Skulls and Quaternary Bones described in the Last Fifteen Years, with an Examination of the Ethnological Elements Characteristic of the Stone, Bronze, and Iron Ages in Central and Western Europe;" (7) "The Light which Ethnographical Survivals can throw on the Social State of the Early Populations of Central and Western Europe;" (8) "How far can Archæological or Ethnographical Analogies be used to support Hypotheses in Regard to Race Connections or Prehistoric Migrations?"

— The council of the Royal Meteorological Society, says *Nature*, have arranged to hold at 25 Great George Street, Westminster (by permission of the council of the Institution of Civil Engineers), on March 19–22 next, an exhibition of instruments connected with atmospheric physics invented during the last ten years, especially those used for actinic and solar radiation observations. The exhibition committee invite the co-operation of all who may be able and willing to send contributions. The committee will also be glad to show any new meteorological instruments or apparatus invented or first constructed since last March, as well as photographs and drawings possessing meteorological interest.

— *Germania*, a quarto fortnightly journal for the study of the German language and literature, edited by A. W. Spanhoofd, has just been published at Manchester, N.H.

— *Leif Erikson* is the title of a new journal to be published weekly at Chicago, under the editorial management of Miss Marie A. Brown, to prove, among other things, that the Norsemen discovered America, and that Columbus was an impostor.

— It is reported from north central Norway and Sweden, so says *Nature*, that wolves are very numerous this winter. They have re-appeared in districts where they have been unknown for many years.

— A new magazine for the blind, in raised Braille type, will shortly make its appearance in London under distinguished patronage. It will contain original articles and reprints of literary matter of a high class, by the best authors of the day, politics being excluded.

— Brentanos have opened a branch at No. 430 Strand, London, which they intend to make "the headquarters of Americans in Europe, as is already the case with their house in Paris, by offering them all possible facilities for keeping fully informed of the doings of American authors and publishers."

— The German Government has granted, according to *Nature*, the sum of £27,500 to repair the building of the University of Berlin, and to erect new lecture-rooms, staircases, and corridors, and for the heating and lighting apparatus. The government has also given £36,500 to the Natural History Museum, besides £2,500 for books. A further sum of £1,000 is to be devoted to the purchase of physical apparatus and an anatomical cabinet.

— We have received a specimen copy of the *Interpretor*, an international review for universal language, edited, with assistance of numerous linguists of different nationalities, by Karl Lentre (Leipzig, Flossplatz 310). It appears monthly, and the subscription price is 50 cents half-yearly. The movement for a world-speech has now entered a new phase of evolution. Whereas formerly only persons of very limited capacity of judgment in linguistic matters have taken up Volapük, the idea of a national artificial speech is now gaining ground more and more among linguists, who examine Volapük and other similar attempts critically and scientifically. This procedure, however, does not suit the Volapükists, who opine that the faults and failings of a system do no harm if only the invention itself can be used. This standpoint is, however, quite untenable, for a language which cannot bear the test of scientific criticism is not likely to possess qualities insuring its lasting success. The *Interpretor*, published in English, German, and French side by side, is to be a central organ for scientific criticism in the department of world-speech, and will also furnish to those who have as yet kept aloof from this movement an opportunity to form a judgment as to the characteristics of Volapük, contrasted with those of a real world-speech gradually to be evolved. The articles in the first number are conceived in this sense. The *Interpretor* is likewise well-adapted, by the way, for the pursuance of studies in German or French. Specimen copies may be had of the publisher, in America, of E. G. Hethorn, New York, P. O. Box 2571.

— The following are from the table of contents of the March number of *The Chautauquan*: "Gossip about Greece," by J. P. Mahaffy of Dublin University; "Alcibiades," by Thomas D. Seymour of Yale University; "Greek Art," by Clarence Cook; "Color in the Animal World," by the Rev. J. G. Wood; "Industrial and Social Effects of the Sewing-Machine," by Ernest Ingersoll; "The Care of Criminals," by the Hon. Z. R. Brockway, general superintendent of New York State Reformatory; "The Commercial Relations of American Countries," by Professor A. D. Morse of Amherst College; "Embezzlers and Defaulters," by John Habberton; "The Italians in the United States," by C. L. Speranza of Columbia College; "The Gladstone Fortune," by C. DeVarigny; "Water-Supply for Small Towns," by John S. Billings, M.D., surgeon United States Army.

— We learn from *Nature* that Professor Fitzgerald and Mr. Trouton have been conducting experiments confirmatory of Hertz's magnificent work. Lately, using parabolic mirrors after the manner Hertz recently described, they have observed the phenomenon of the polarization of radiations by reflection from a wall three feet thick. They observed long ago, and exhibited publicly at the opening meeting of the Experimental Science Association last November, that stone walls are quite transparent to these radiations, as they should be, and consequently should not reflect radiations polarized perpendicularly to the plane of incidence at a certain incidence. This is what has been observed, and it has been decided that the plane of polarization is the plane of the magnetic disturbance. They next tried reflection from sheets of glass, and obtained no results; but, as Mr. Joly suggested, the experimenters were practically observing the black spot in Newton's rings, for the sheet of glass was much thinner than a wave-length, which is about thirty centimetres. Some rough observations at various incidences from the wall seem to show interference at some and not at other incidence due to the same cause as Newton's rings.

SCIENCE:

A WEEKLY NEWSPAPER OF ALL THE ARTS AND SCIENCES.

PUBLISHED BY

N. D. C. HODGES,

47 LAFAYETTE PLACE, NEW YORK.

[Entered at New York Post-Office as second-class mail-matter.]

SUBSCRIPTIONS.—United States and Canada.....$3.50 a year.
Great Britain and Europe..... 4.50 a year.

Science Club-rates for the United States and Canada (in one remittance):

1 subscription	1 year	$	3.50
2 "	1 year		6.00
3 "	1 year		8.00
4 "	1 year		10.00

Communications will be welcomed from any quarter. Rejected manuscripts will be returned to the authors only when the requisite amount of postage accompanies the manuscript. Whatever is intended for insertion must be authenticated by the name and address of the writer; not necessarily for publication, but as a guaranty of good faith. We do not hold ourselves responsible for any view or opinions expressed in the communications of our correspondents.

VOL. XIII. NEW YORK, FEB. 22, 1889. No. 316.

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THE UNITED STATES will make a creditable display at the Paris Exhibition. And this is as it should be; for, although nominally a universal exposition, it will be practically a display of the products of republics. The monarchies of Europe will be represented only by private exhibits, while the republics of North and South America have rallied in force. The United States Department of Agriculture will make a splendid showing. Secretary Colman has placed the undertaking in the hands of Professor C. V. Riley, the famous entomologist, an energetic organizer as well as a careful and enterprising scientific observer; and Professor Riley has already sent forward three car-loads of products, which are on the way to France in charge of Mr. F. T. Bickford, an assistant. The bulk of shipments are nearly through with, and the perishable staples will follow during the next month. Congress appropriated $250,000 to aid exhibiters, and Secretary Colman's quota of this will insure the best illustration that the agricultura. resources of this country have ever had on the continent of Europe Various branches will be represented as follows: fruit, Professor VanDeman and Professor George Hussman; grain, George N. Hill, St. Paul, Minn.; cotton and fibres, Col. James A. Benford, Duck Hill, Miss., and Charles R. Dodge, Boston; tobacco and peanuts, Alexander McDonald, Va.; agricultural education and experimental stations, W. O. Atwater, Department of Agriculture; vegetables, including hops, M. G. Kern, St. Louis; entomology, including apiculture and silk-culture, C. V. Riley, N. W. McLean of Hinsdale, Ill., and Philip Walker, Department of Agriculture; sorghum and other sugar-plants, H. W. Wiley, Department of Agriculture; forestry, B. Fernow, Department of Agriculture, and M. G. Kern of St. Louis; grasses and forage-plants, George Vasey, Department of Agriculture; meat products, Dr. de Salmon, Department of Agriculture. All articles for exhibition will be forwarded free from New York, and no charge will be made for space in Paris. Professor Riley has put forth unusual exertions to get the exhibit on the road, and he looks forward with much enthusiasm to the result. He will not leave for Paris till the first week in April.

PHOTOGRAPHIC MAP OF THE NORMAL SOLAR SPECTRUM.

A NEW and greatly improved edition of this map, made by Professor H. A. Rowland, extending from the extreme ultra violet down to and including B to wave-length 6950, is now ready. The old map, published in 1886, was made by means of a grating ruled on the old dividing-engine, which was originally intended for only small gratings, and at a time when Professor Rowland's knowledge of photography was limited. Furthermore, it was not printed in a sufficiently careful manner; and the negatives, which were originally none too good, soon became broken or defaced, so that many of the prints, especially the later ones, were not satisfactory.

The whole work has now been gone over again. A new dividing-engine to rule large gratings has been constructed, and has proved to be superior in every way to the old one, although the old one is almost equal to it for small-size gratings. It has been placed in the vault of the new physical laboratory, where an almost constant temperature is maintained. Several concave gratings of 6 inches diameter and 21½ feet radius have been ruled with 10,000 or 20,000 lines to the inch, giving definition hitherto undreamed of. These have been mounted in the best possible manner. The laboratory contains rooms for developing, making emulsions and dry plates, complete enlarging apparatus, and, indeed, every facility for photographic work on the spectrum of the sun; and a large steam-engine, a variety of dynamos, continuous and alternating current, with Ruhmkorff coils of all kinds, one of which latter will melt down iron wire larger than one-sixteenth of an inch in diameter in the secondary circuit, give means of future investigation on the spectrum of the elements. Professor Rowland has devoted years to the making of dry plates, simple and orthochromatic, and is thus better prepared than before for the work of making the map. He has also revised his list of standard wave-lengths, and extended them into the ultra violet, and has placed the scale upon the photographs with greater care than before. The printing is carried on in Baltimore, where it is under the immediate supervision of Professor Rowland.

The negatives have been made on thick French plate glass, and the prints are much more artistic than the old ones. The definition is not only much finer throughout, but the prints are much more uniform, and have fewer spots.

The process of making this map is the same as that used for the old one, and is based on the property of the concave grating as discovered by Professor Rowland: this property is, that the spectrum, as photographed in any given order, is normal, and of the same scale throughout. The focus remains automatically adjusted, so that one has only to move the instrument to the part of the spectrum required, absorb the overlying spectra, and put in the photographic plate. The negatives enlarged have been selected from many hundreds taken from different gratings, though three gratings were finally selected for the work. The negatives from any given order of spectrum are measured from one standard line to another on a dividing-engine, so that the constant of the dividing-engine is known. The scale is then made by ruling on a piece of French plate glass having a coating of blackened collodio-chloride. The negatives are then clamped to the scale firmly, after being adjusted into position by the standards. They are then put in the enlarging apparatus, and the whole enlarged from two and a half to possibly

four times, so as to make the scale of the map about three times, that of Angström's map. The positives thus made are then figured, and negatives made from them by contact.

In the negatives so far examined, the scale has been placed within less than $\frac{1}{20}$ Angström division, or $\frac{1}{100000}$ wave-length of its true position.

As to the definition, much is lost in the enlargement, not so much from want of definition in the enlarging lens, a 25 by 21 inch Dallmeyer, rapid rectilinear, as from the radical defect of photographic processes; for, when one brings out the fine doubles in which the streak of light in the centre is very faint, he loses many of the fainter lines. The original negatives show E, and even finer lines like that at wave-lengths 5276.1 and 5914.3, plainly double, but there is little hope of showing this on the map.

The atmospheric line just outside of one of the D lines also nearly merges into it, although in the original negative it is widely sundered from it.

However, there are few instruments which will show more of the spectrum than can be found on the map, even below the D line, where cyanine and chlorophyl plates had to be used, for the first line in B is shown widely triple. Above, and including the D line, the definition rapidly improves, and a low-power magnifier must be used to bring out the full definition. However, from wave-lengths 5300 to 3800 the superiority over the old edition is not so marked as above and below this. In the ultra violet above H there is an immense improvement in the new, both in definition and in the quality of the photograph.

As to comparison with other maps of the spectrum made by measurement and drawing, it may be said that no comparison is possible. The photograph is the work of the sunlight itself, and the user of this map has the solar spectrum itself before him, and not a distorted drawing full of errors of wave-length and of intensity. The superiority is so great that there is no possibility for comparison.

The following is a list of the plates, each 3 by 2 feet, containing two strips of the spectrum: *a* includes from wave-length (?) to 3350; *b*, from wave-length 3270 to 3730; *c*, from wave-length 3670 to 4130; *d*, from wave-length 4050 to 4550; *e*, from wave-length 4450 to 4950; *f*, from wave-length 4850 to 5350; *g*, from wave-length 5250 to 5750; *h*, from wave-length 5650 to 6150; *i*, from wave-length 6050 to 6550; *j*, from wave-length 6450 to 6950.

Negatives *b*, *c*, *d*, *e*, *f*, *g*, *h*, *i*, *j*, are now ready, although that for *i* is too irregular to be entirely satisfactory, and it may be replaced. The plate *a* to the extremity of the solar spectrum will be attempted this summer, but may cause much trouble and delay, and will be sold as an extra plate. The prints are on heavy albumen paper mounted on cloth.

The cost of printing has been so much increased that the prices for this new series will be greater than for the old one, but scarcely more than covers the cost of the printing.

The plates will be delivered in Baltimore or New York, or will be sent by express or mail, securely packed, at the charge and risk of the purchaser, at the following net prices: set of nine plates, wave-length 3270 to 6950, $18; single plates, $2.50. Should any extra plates continuing the spectrum in either direction be published, subscribers can have them at $2 each. Subscribers to the old edition will have the preference in the delivery of the new one, and a reduction of 10 per cent in the price. The three plates *h*, *i*, *j*, to complete their set, will be furnished for $6. They are advised to take *g* also, as the old map of that region was bad. The four, *g*, *h*, *i*, *j*, will be furnished to them for $8.

Two plates, each 3 by 2 feet, suitable for framing and hanging on the wall, have been made of the B and D lines. The latter are 3 inches apart, and the former has an extent of about 24 inches. Enlargements of some of the carbon bands from the arc electric light have also been made. They show the wonderful structure of these bands, each containing many hundred lines, each one of which is a close double, or, in some cases, a triple. These plates will be sold for $2.25 unmounted, or $2.50 mounted on cloth. No plate will be given away or sent in exchange. Remittances may be made by draft or money-order. All subscriptions and orders should be sent, and remittances made, to the Publication Agency of the Johns Hopkins University, Baltimore, Md.

THE EARTHQUAKE OF LIGURIA, FEB. 23, 1887.

MESSRS. T. TARAMELLI and G. Mercalli have made an exhaustive report on the earthquake of Liguria in February, 1887, to the Italian Department of the Interior. A geological and an historical chapter form the introduction, which is followed by an account of the results of the authors' studies and inquiries. They visited all localities that were severely damaged by the shocks, while information on others, which they were not able to visit, was collected by means of circulars of inquiry. Thus exhaustive reports on the character of the earthquake were obtained from over eleven hundred localities. This abundant material, arranged and discussed systematically, forms the basis and the main part of the report. The results of this discussion are summarized by the *Naturwissenschaftliche Rundschau* as follows: —

Many insignificant, preparatory shocks preceded the Ligurian earthquakes of 1752 and 1854, as well as that of Feb. 23, 1887. In the night from Feb. 22 to Feb. 23, four light shocks were felt over exactly the same territory that was visited by the severe shocks of the following day. Evidently the seismic centre was in full activity that night; but there are only four indications, as no seismic instruments and observers exist on the Riviera di Ponente. A little while before the earthquake began, the sea was observed to be exceptionally quiet. A few observers claim to have seen unusual lights in the atmosphere. In the regions which suffered most severely, animals were observed to be restless. In a very few places a change of springs was observed. Thermometer and barometer were not influenced by the shocks.

The principal shock was observed in a circular area covering about 568,000 square kilometres. Its southern limit is Rome and Mount Ferru in Sardinia. Eastward it extends to Pordenone, westward to Perpignan, and northward to Dijon and Basle. The shocks spread with greater force northward to France and western Switzerland, than southward on the Italian peninsula. According to the intensity of the phenomena, the authors distinguish four zones; the central region, in which the most formidable destruction took place, forming a zone a hundred kilometres in width along the coast from Mentone to Albissola. It embraces a narrow coast strip, because the seismic centre was situated in the sea, and because the old crystalline rocks of the Ligurian Apennines reflected the seismic waves. The next zone is called by the investigators the "almost destructive" one. It extends to the hills of Piedmont. Very strong shocks were felt in the third zone, which extends from the second principally north-westward, including Turin and the low-lying Canavese, where the shocks seem to have been increased in violence by waves reflected from the gneissic mass of the Grand Paradiso. The last zone embraces those places in which the earthquake was felt, but did not do any damage.

In the whole territory where the earthquake was strongly felt, the first shock lasted thirty seconds, and consisted of two shocks almost immediately following one another. Each of these shocks caused first a subsultory, then an undulating motion. In no place, not even in those where the shocks were most destructive, was the movement vertical. Therefore the resultant of both shocks was much influenced by local causes, and neighboring places show great differences in the direction of the shocks. The second shock was the stronger one, causing particularly a strong subsultory movement. Only in Nice and other places in France the first shock was the strongest. The second part of the shock was everywhere complicated by the resultant action of its combination with the first shock. This accounts for the fact that the second shock frequently left the impression of a rotatory movement. In many places, for instance in Mentone, objects lying on the ground have been turned round. In places lying at greater distances from the central point, the vertical component decreased rapidly, but all the other peculiarities of the shock remained. In the outlying zone the slowness and regularity of motion of the shock were remarkable, which caused pendulums three feet and more in length to swing.

At various places the horizontal velocity caused by the shock was determined by observations, and by objects thrown some distance. At Oneglia the force was large enough to give a portion of a sill, weighing about five thousand pounds, an initial velocity of thirty-one feet. This horizontal force decreased with increasing distance

from the centre. At Taggia it was twelve feet; at Nice, fifteen feet.

In many places of the region where the earthquake displayed its greatest power, some observers claim to have heard a noise preceding the motion. To some it seemed to be similar to the rattling of a train; but it is more generally compared to the howling of a hurricane, or to the rattling of a cart rolling over a stone pavement, or to distant thunder. Even in the third zone there are numerous places in which the noise was heard before or during the shock. In the fourth zone it was noted in very few places. In several places in the province of Porto Maurizio a subterranean noise was all that was observed; it was not followed by any movement.

Great care was given to the determination of the direction of the first shock. The methods applied were to inquire into movements of lamps and other hanging objects, the stopping of pendulum clocks, the removing or falling of objects, and the destruction of buildings. This part of the investigation showed, that in the whole region of the Ligurian Apennines, which was shaken most violently, all directions were equally frequent. This fact suggests the existence of an elongated epicentre parallel to the Ligurian coast. East of the meridian of Oneglia, directions between east-north-east to west-south-west and north-east to south-west prevailed. West of this meridian the greater number of waves were in the directions from east to west and from south east to north-west. In many places the direction of the movements changed once or twice during the first shock. Thus movements resulting directly from the shock, and secondary waves, could readily be distinguished. In many cases, among the various directions, two were prevalent which were vertical on one another.

A remarkable phenomenon was observed in the valley of Padua. The direction pointing towards the centre of the disturbance existed only during the latter part of the shock. In the beginning the crystalline rocks of the West Alps, which were shaken a few moments before the neighboring recent deposits, deflected the waves towards the arc of the valley of Padua, giving them an east and west direction.

If all important directions of shocks are marked on a map of western Liguria, they will be seen to converge in the sea between Oneglia and St. Remo about fifteen or twenty-five kilometres south of the coast. Therefore this is the probable place of the epicentre. The same place results from a study of the isoseismic lines which are concentric to a point twenty kilometres south of Porto Maurizio. A secondary centre seems to have been in the sea south of Nice.

A comparison of the most trustworthy reports shows that the Ligurian coast between Nice and Laona was struck by the great shock at 6.20 A.M.: therefore the shock must have reached the epicentre a little before this time, probably at 6.19 A.M. If this movement is considered the beginning of the shock, and the time of the disturbances observed at other places is compared to it, it appears that the velocity of transmission was not equal in all directions. It was greater to the west, being 4,762 feet in the direction of Marseilles and Nice, and only 1,916 feet in that of Genoa. This difference is probably not real, as the first shock of Nice seems to have originated at a secondary epicentre south of Nice, the existence of which was known through the earthquakes of 1564 and 1752.

Only in a few places was it possible to ascertain the vertical angle of the shock with any degree of exactness; but the value of 40° seems to be well assured by observations between St. Remo and Albenga. Based on these observations, and on the fact that this angle decreased with increasing distance from the epicentre, slower than it did in the great Andalusian earthquake of Dec. 25, 1884, the seat of the centre was found to be at a depth of eighteen kilometres, while that of the secondary centre south of Nice was somewhat less. It seems probable that the shocks preceding and following the most violent one also proceeded from the main centre, but that the first originated in a greater, the later in a less depth. The centre seems to have approached the surface during the seismic phenomena.

The violent shock was felt at sea between Corsica and the western Riviera by several vessels, which were shaken in all directions, the impression being that they had struck a rock. Almost everywhere on the Riviera the sea fell a little at the moment of the first shock, and suddenly returned to its former level, without the destructive waves which have followed other earthquakes. Some observers maintain that the falling continued several days after the earthquake, while at Laona and Porto Maurizio a change of level is said to have taken place. No rise is said to have followed the first fall. At Nice, St. Remo, and Savona dead fish were collected after the earthquake. According to Bellotti, all of them were deep-sea fish: therefore it cannot be doubted that violent shocks occurred in considerable depths near the coast of Liguria. This confirms the opinion that the centre must have been under the sea.

The earthquake did not cause any important changes in the topography of the affected region, and all of them must be considered dynamical effects of the tremors upon the surface strata which were broken or slightly moved. None of the resulting changes are connected with the prime cause of the earthquake. No atmospherical phenomena proving the presence of an extraordinary amount of atmospheric electricity were observed. In this respect the Riviera earthquake differed from that of Andalusia.

About nine minutes after the first shock a second one followed, violent and long; then at 8.53 A.M. (Rome time) a third one, short, but almost as violent as the first, and very destructive in its effects. Both these shocks were felt slightly in the whole region disturbed by the first one. In the central zone about twenty-two shocks more were felt in course of the 23d and in the following night. Only one, at 2.20 P.M., was strong. After the 23d the number of shocks decreased; but they continued until March 11, when the most violent shock since the first three was felt. At Savona, between Feb. 23 and March 11, about fifty distinct shocks were felt. Only the shocks of Feb. 23 were destructive. Six hundred and forty persons were killed, and about as many wounded. The damage in the province of Porto Maurizio is estimated at $2,600,000; in the environs of Albenga and Savona, at $1,700,000. No detailed estimates are available from the French districts.

NATURE AND ORIGIN OF PHOSPHATE OF LIME.[1]

THE circumstances which have led to the preparation of the subjoined report on mineral phosphates are as follows: viz., in 1870 the present writer was employed by the superintendent of the Coast Survey, the late Benjamin Peirce, to examine the phosphate beds of South Carolina with a view to determining the limits of that field; it was also deemed desirable to ascertain, if possible, the conditions which led to the formation of the deposits.

It was at that time the intention of Professor Peirce to have the geology of the belt of country within the limits of the Coast Survey maps carefully determined, so that they might be shaped in a way that would better serve the commercial interests of the country, and also have a greater scientific value. After a time it appeared that there were legal difficulties in the way of publishing these studies in the reports of the Coast Survey, and this work was suspended. It was the hope of Professor Peirce to secure a modification of the law; but before this was accomplished, he retired from the post of superintendent, and his successor deemed it best to abandon the project. During the two years in which I was engaged in this work on the geology of the coast line, I became very much interested in the problems connected with the origin and distribution of phosphatic deposits. From 1873 to 1880, while employed as State geologist of Kentucky, I had a chance to see a good deal of the somewhat phosphatic limestones of the Cambro-Silurian sections, — a set of beds which, by their decay, have given great fertility to the soils that lie upon them. The researches of Dr. Robert Peter, the chemist of that survey, made it plain that the phosphatic contents of the soils are among the first materials to be exhausted by the careless tillage which characterizes our American agriculture, and that they are the most costly to restore to the soil.

Extending the general inquiry to the grain-producing districts which lie to the north and west of Kentucky, it became evident that all those States which are now the granary of this country, and the chief source of supply for European markets as well, are rapidly exhausting their soils, and will soon be in grave need of

[1] Portion of an introduction, by N. S. Shaler, to a forthcoming bulletin of the United States Geological Survey, prepared by R. A. F. Penrose, jun.

phosphatic manures. The importance of such manures has so far been well recognized only by the cotton-growers of this country, yet it is evident that in a short time this class of fertilizers will be equally in demand for all forms of grain-crops.

These considerations have led me to the conclusion that the geological history of phosphatic deposits should receive more deliberate attention than has yet been given to it.

When I began my work in the United States Geological Survey, I asked permission of the director to continue my studies on phosphatic deposits. There was at the time no money available for these studies: it was therefore necessary that they should be carried on without other expense to the survey than that involved in the small share of my time which could be given to the supervision of the work. It was my good fortune, however, to find in one of my students of geology, Dr. R. A. F. Penrose, jun., a person who has been willing, at his own cost, to undertake a preliminary study of the whole field as far as our knowledge extends, and thus to prepare the problems concerning American phosphate deposits for detailed inquiry. This work he has pursued with great intelligence and energy during the two years in which he has been engaged in it. In this task he has examined all the known phosphate deposits of the United States and Canada, and has made a careful inquiry into the literature of the subject, as is shown by the extended bibliography which is appended to his report.

The object of this work being to make a necessary preparation for the further study of American phosphatic deposits, Dr. Penrose's studies were not designed to be encyclopedic in their scope, but rather to afford a synopsis of what is known of the deposits in this and other countries. So little is yet generally known of the several conditions under which these deposits may occur, that it would be very blind work to search for them in this country without a careful endeavor to bring together the experience which has been gained in other countries. It will be evident to the reader of Dr. Penrose's report that the workable deposits of phosphates are found in a greater variety of circumstances than those which contain most mineral substances that have an economic value. It is not likely that we have as yet exhausted the inquiry into the modes of occurrence of this substance; but this synopsis of the experience in this and other countries, which is much more extensive than any other which has been published, will, I believe, serve as a guide to the further search for sources of supplies of phosphatic manures. It will also be evident to the reader that the conditions of occurrence of these deposits in Europe make it plain that the search for them in this country may advantageously be directed to many districts in which they have not as yet been found.

So far, the vein deposits of apatite, such as those which are so abundant north of the St. Lawrence, have not been found in workable quantities within the limits of the United States, though the general geological conditions of the Laurentian area exist in the Adirondack district and in the southern parts of the Appalachian system, as well as in several districts of the Rocky Mountains. It would be remarkable if extensive deposits of this nature, so common in Canada and in the equivalent rocks of northern and southern Europe, should not be found at many points in our American Archæan formations. It is on this account that so much space in this report is given to the description and illustration of the Canadian apatite deposits. So, too, we may hope to find in the ancient rocks of this country deposits analogous to the great Logrosan and Caceres veins in the province of Estremadura, Spain.

The cretaceous deposits of Belgium (which at the present time are, next after the phosphate beds of South Carolina, the most productive in the world) present a type of beds the like of which have not as yet been discovered in the United States, though deposits of the same age, formed under about the same conditions, abound in this country. It is not to be expected that phosphatic deposits will exactly repeat themselves in strata of the same age in widely separated regions; yet it is clear, from the summary account of the geological distribution of these phosphates in Europe and North America, that in the case of these, as well as in that of other substances of value in the arts, there are certain guiding principles which we may base on the stratigraphy of the deposits to aid our search. The known workable deposits of a phosphatic nature are limited to certain portions of the geological section. Beginning at the surface, the deposits now forming these zones are, in descending order, as follows: —

(1) Superficial deposits, including (*a*) those formed in the manner of guanos; (*b*) the deposits formed in the bottoms of fresh-water swamps, sometimes in connection with deposits of bog iron ore (hematite); and (*c*) deposits which are the result of the long-continued decay of rocks containing a small portion of lime phosphate intermingled with lime carbonate, as, for instance, the deposits of North Carolina. This superficial group of deposits has no other common feature save that they are on the surface, and are due to causes now or recently in action.

(2) Deposits of the tertiary and upper cretaceous. These deposits are generally the result of re-actions which took place on ancient land surfaces, the phosphatic matter being such as formed in swamp beds or in ablation deposits like those of the Carolinas or of eastern England. Below the level of the cretaceous no important deposits of phosphate have been found in the vast section of rocks which lies between that era and the Devonian horizons.

(3) In the horizons below the level of the upper Silurian, bedded rock phosphates and apatite deposits occur. These infra-Devonian bedded rock phosphates seem to have derived their phosphatic matter from the animals, brachiopods, and small crustaceans, which separated that substance from the sea insects or other food which the old oceans afforded them. These phosphate-bearing invertebrates appear to have been particularly abundant in the early paleozoic seas.

(4) Below the level of the Silurian the phosphatic deposits which have been worked probably belong altogether to the class of apatites or crystallized lime phosphates, and are probably all new deposits. They evidently occur through a large part of the Laurentian section, though, so far, the known deposits of economic importance are possibly limited to one portion of that vast series of rocks.

The apparent absence of phosphatic deposits of economic importance in the section between the Devonian and the cretaceous is remarkable. It is possible that it may be due to our lack of knowledge as to the chemical character of the deposits in those parts of the earth's crust. It is more likely, however, that such deposits do not there exist, owing to the fact that the invertebrate species of animals which secrete phosphatic matter in their skeletons became relatively less abundant in the middle portion of the geological section; while the vertebrate species, the birds which accumulate guanos, and the fishes which afford an abundance of bones and teeth to littoral deposits, as well as the mammalia whose skeletons occasionally form a considerable element in the later deposits, did not begin to contribute phosphatic matter to the rocks until comparatively modern times.

The absence of phosphatic deposits in the upper paleozoic and lower mesozoic strata is well shown by the fact, that, while in the carboniferous and the triassic beds there are abundant land surfaces which have been carefully explored, no phosphatic deposits of economic importance have been found in them; while on the relatively very limited areas of the tertiary and cretaceous formations, where old land areas have been explored, a large number of deposits of beds of nodular phosphate have been found.

From the facts set forth in Mr. Penrose's report and the unpublished results of certain studies on swamps, we may draw certain general conclusions as to the best method of prosecuting the search for unknown deposits of American phosphates. These conclusions are essentially as follows: —

First, as regards the superficial and recently formed deposits of phosphates. We are driven to the conclusion that this class of deposits may reasonably be sought for wherever soft calcareous beds containing a certain amount of lime phosphate have been subjected to long-continued leaching by waters containing the share of carbonic-acid gas which belongs to all rain-water after it has passed through the mat of decayed vegetation. As long ago as 1870 I became convinced that it was to the leaching-out of the carbonate of lime by the carbonated water of the soil bed that we owe in the main the concentration of the nodular phosphates of South Carolina.[1] Although it is still necessary to explain many of the details of this process to adapt it to the peculiar circumstances of particu-

[1] See Proceedings of the Boston Society of Natural History, xiii., 1871, p. 222.

lar deposits, it seems to me that it is the key to the most common forms of superficial accumulations of nodular phosphates. In an admirable description of the phosphate beds in the neighborhood of Mons, in Belgium, by Mr. F. L. Cornet,[1] that distinguished author has independently propounded this simple hypothesis, and several other writers on the subject have apprehended the importance of this leaching action.

It is evidently essential to this process of concentration that the surface of the deposits which are leaching away should have been preserved from the action of mechanical erosion, which would have prevented the formation of phosphatic concentrates.

Inquiry into the conditions of the swamp deposits of this country has satisfied me that beneath the surface of many of our fresh-water marshes, and probably in a lesser degree beneath the marine deposits of the same nature, there is a more or less important concentration of lime phosphates constantly going on. The effect of this action is seen in the remarkable fitness of these fresh-water swamp soils for the production of grain-crops. For instance: in the case of the Dismal Swamp district, in Virginia and North Carolina, we find that the soils on which the swamp deposit rests are extremely barren, while in the mud that has accumulated beneath the swamp we have a rich store of phosphates, potash, and soda, which causes the soil of these swamps to be extremely well suited to grain-tillage as soon as it is drained. In a similar way, in the swamps of New England and Elsewhere, we find the bog iron ores which are frequently accumulated in their bottoms very rich in phosphatic matter. The evidence is not yet complete that this phosphatic material becomes aggregated into nodules in the swamp muds, but the number of cases in which nodules have been found in this position makes it quite likely that the nodulation of the material may go on in that position. The present condition of the inquiry goes, in a word, to show that wherever we have a region long overlaid by swampy matter we may expect a certain concentration of lime phosphates in the lower part of the marsh deposit. Wherever the swamp area lies upon somewhat phosphatic marls which have been slowly washed away by the downward leaching of the waters charged with the acids arising from decayed vegetation, or where the swamp deposits, even when not resting on such marls, are in a position to receive the waste from beds containing phosphates, we may expect to find a considerable concentration of phosphatic matter in the swamp bed. By the erosion of these swamps we may have the nodules of phosphate concentrated in beds such as occupy the estuaries of the rivers near Charleston, S.C.

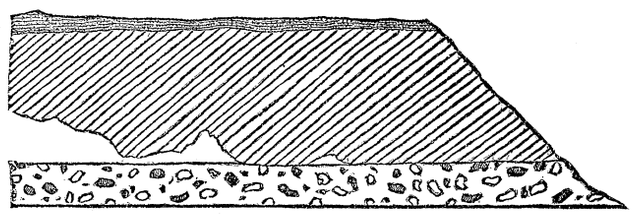
The area of swamp lands which fulfil these conditions is very large. They exist in numerous areas in more than half the so-called Southern States. At present it can only be said that they afford the conditions which, so far as the theory goes, should lead to the accumulation of phosphatic deposits of greater or less importance. It will be a simple matter to explain these deposits, though it is a task requiring a patient study of a large field. Although it is likely that the phosphatic materials will be found aggregated into nodules at many points in this area, it will not be safe to assume that they will be found in the same form as those which occur about Charleston, S.C. The nodules found in the beds about the last-named point, though in my opinion originating beneath swampy deposits, have apparently been, in part at least, swept from their original beds by the rivers which enter the sea at that point, and have thus been concentrated in estuarine deposits.

Although local concentrations of phosphatic nodules other than those now known may well be sought for in the Southern States, I do not think that the precise conditions or character of the deposits as found at Charleston should be expected to repeat themselves elsewhere. It is characteristic of the process of concentration of phosphatic as well as of other matter into nodules, that the material takes on a great variety of aspects, each proper to a particular site, and this although the surrounding circumstances of the several localities may apparently be identical.

Next lower on the geologic section we have, in the tertiary region of the Mauvaises Terres, extensive deposits of vertebrate remains which may possibly yield some commercially important supplies of bone phosphates. Although none of the existing sources of supply of these materials come from deposits of the nature of those found in Nebraska, the conditions of that remarkable region are so peculiar that it will not be well to pass it by without inquiry.

While the American cretaceous deposits are, as a whole, decidedly different from those of the Old World, the greensand beds of the section in the two countries present considerable likeness in their characters. It is probable that in this country, as in Europe, considerable parts of the cretaceous section are somewhat phosphatic, and that these beds containing disseminated phosphatic matter have been in many places exposed to the process of leaching in former geologic periods: therefore we may reasonably search in the cretaceous beds of this country for the same class of phosphatic deposits which have proved so important in the northern parts of Europe.

Although some peculiar deposits of phosphate have been found in the Devonian rocks of Nassau, it may safely be assumed that below the line of the cretaceous we have no facts to guide us in our search for phosphates until we come to the horizon of the upper Silurian limestones, at about the level of the uppermost beds of the upper Silurian, as far as that level can be determined by the perplexing assemblage of fossils. There occurs in Bath County, Ky., a thick bed of much decayed, very phosphatic siderite. This deposit covers but a small area, and consists of a patch of limestone of about fifteen feet thick, which has been converted into siderite by the inleaching of iron-bearing waters from the ferruginous Ohio (Devonian) shales which formerly overlaid the bed. Since the escarpment of the Ohio shales retreated beyond this bed, it has been subjected to oxidation, and is now in the main converted into a much-decayed limonite. Beneath this limonite there is a greenish argillaceous sand, which contains frequent nodules of lime phosphate. These nodules are smooth-surfaced, and not unlike some of the nodules from the Carolina district. They contain as much as 92 per cent of lime phosphate. It seems likely that these nodules were formed by the leaching-out of the lime phosphate from the overlying ferruginous layers, which has completely removed the lime carbonate, but has not removed the whole of the less soluble lime phosphate.



SECTION AT OLYMPIA, BATH COUNTY, KY. (PRESTON ORE BED).

Although this deposit of nodules is not of sufficient abundance to have any economic value, it is clear that we have in it an indication of a method where, by a slight variation of the conditions, important beds of nodular phosphates might be found.

In the horizons of the Cambro-Silurian section, or, as it is generally called, the lower Silurian, there is much greater reason to expect the occurrence of workable phosphates than in the beds immediately above. It is likely that the most important of the Spanish deposits belong in strata of this period, and the Welsh deposits of this general age are of noteworthy extent. We know, moreover, that the commoner marine animals of this part of the geological section were particularly adapted for the secretion of lime phosphate.

The search of this portion of the section for phosphates should be directed to two ends: first, to finding beds of very phosphatic limestone; and, second, to discovering veins formed by a segregation of lime phosphates either in the form of the Spanish deposits referred to by Dr. Penrose or in the condition of nodular accumulations. The area of rocks of these lower Silurian and Cambrian periods in this country is very extensive, and so far there has been no search of them for phosphatic materials. The little work done in Kentucky during the above-mentioned geological survey served only to show that the proportion of lime phosphate in the rocks is extremely variable, and that in certain beds it is so considerable that the ma-

[1] See Quarterly Journal of the Geological Society, London, xlii., 1886, p. 325.

terial might advantageously be used in a local way for fertilizing purposes.[1]

The search for phosphatic materials in the stratified rocks demands a method of inquiry that has not yet been applied to the study of our rocks. It seems to me that the method, or rather methods, should be as follows: —

First, there should be a careful inquiry to determine the share in which the several important groups of rock-making organic forms contribute phosphatic matter to strata. This can be accomplished by carefully comparing the chemical character of particular strata with the fossils the beds contain. When this determination is made, we shall have one means of guiding our inquiries, which will surely be of great value in the search for bedded phosphates.

Second, we should have a carefully executed chemical survey of our stratified rocks. Enough can be gathered from the scattered records of chemical analysis to make it plain that certain features of the chemical character of particular beds or divisions of strata often extend laterally for great distances. This is shown in a general way by the character of the soils formed of the waste of particular horizons; for instance, the deposits of the horizon on which lies the Cincinnati group of this country and the equivalent deposits of Europe are nearly always well suited to grasses and grains, and have a great endurance to tillage. It is now desirable to take these beds which promise to afford mineral manures, and subject each stratum to analyses which shall determine the quantity of phosphoric matter, soda, and potash which they contain, so that their fitness for use as mineral manures may be ascertained.

Below the level of the Silurian and Cambrian strata, and partly in those sections where they have been much metamorphosed, lies the field of the vein phosphates. It is more than likely that in this vast thickness of rocks, with their development in this country, there are many extensive sources of this class of phosphates which await discovery. As yet no careful search has been made for such veins in any part of the United States. The regions most likely to contain such deposits are found in the central parts of the Appalachian system of mountains, especially in the section from Virginia southward; in the Archæan district of Missouri and Arkansas, and in the vast region of highly metamorphic rocks of the Cordilleran district, extending from the Rocky Mountains to the Pacific Ocean. It is true that at present the economic value of phosphatic deposits in the western part of the continent would probably be small, on account of the great cost of transportation to the seaboard districts. But the growing use of phosphatic manures in the Mississippi valley, and the rapid exhaustion of the soils of that district, will soon give commercial importance to any sources of supply of phosphates that may be found in any parts of the Cordilleras which are convenient to transportation.

A proper study of the mineral manures of this country can best be carried on by means of a well-considered co-operation between geological explorers and the experiment stations of the several States. At present the methods of using mineral phosphates are extremely costly. Not only is the material brought into the soluble condition by saturation in sulphuric acid, but it is then mingled with ammoniacal and other matter to increase its effect as a fertilizer. The result is, that although a ton of Carolina phosphate now costs but six dollars, the average price of the manufactured product to the consumer at the phosphate factories is about thirty dollars per ton. It is probable that the essential value of the phosphatic ingredients to the plants of most soils is not enhanced by this costly treatment, though an incidental but dearly purchased gain, in the case of some crops, is obtained from the ammoniacal matter. The only effect of the superphosphatizing on the phosphatic matter is to make it more immediately absorbable by the plants. If placed on the soil without any other preparation than grinding, lime phosphate will slowly pass into a condition in which it may be absorbed by plants, while, if treated with sulphuric acid, it is, for a time at least, in a soluble state. That this treatment is not essential is well shown by the fact that the phosphatic matter derived from the rocks is brought into a condition for absorption by the ordinary process of decay in soils. Our present costly method of applying phosphates has come about through the commercial history of artificial manures, which is as follows: —

Before guanos were brought into use, the English farmers had learned that they could profitably use the phosphatic marls of their tertiary and cretaceous deposits without any artificial preparation. If guanos had not existed, it seems likely that mineral phosphates would have always been used in this way. When the Peruvian guanos came into use, they afforded a much more stimulating material than any other purchasable manures, and in a short time they established the type of commercial fertilizers. When the sources of supply of these guanos became in part exhausted, artificial compounds, formed on a basis of rock phosphates or apatites, were devised to take their place. These were made to imitate the effect of the guanos as closely as possible. Like them, they gave a quick though temporary stimulus to the soil, enabling the farmer to obtain the greater part of the return for his investment in the season following the application of the high-priced manure. Very generally the fertilizer, guano or compounded material, was applied with the seed or dibbled in the soil alongside the young plant; so that it would be immediately available in the first stages of its growth, and, what is a more important consideration, that it might take less of the substance to give the effect than if it were sown broadcast over the surface or mingled with the soil of the whole field.

In this way a habit has been established in the art of using phosphates, as well as in the composition of the material, which, like all commercial habits, is hard to overcome. The question to be determined is as to the utility of phosphates with other modes of treatment than those which are applied in the imitation guanos. At present this treatment requires the commingling of the lime phosphate with a number of costly substances. The manufacture can only be advantageously carried on at points remote from the districts where the materials are produced, and remote from the fields where they are used, so that the costs of transportation are great. The problems to be solved by the agricultural stations are as follows: —

(1) As to the effect, immediate as well as permanent, arising from the application of ground phosphatic rock commingled with other materials on soils used for the production of different crops.

(2) As to the degree of comminution of the material which is most advantageous. It seems possible that fine pulverizing may take the place, in a measure, of superphosphatizing.

(3) As to the effect of mingling the powdered rock with ordinary barnyard manure, peat, and other similar substances.

(4) As to the effect of lime phosphate used alone on soils containing different mineral constituents; as, for instance, those having considerable proportions of lime carbonate, and those having but little of that substance.

(5) As to the proportion of the lime phosphate which it is necessary to apply in order to produce different degrees of effect upon the fertility of soils.

It is desirable that these and other experiments should be tried at a number of stations in different parts of the country, in order that the needs of various crops may be considered, and the effect of the fertilizers on different classes of soils ascertained.

The effect of a small amount of lime phosphate on the fertility of the soil is clearly great; but, so far, we do not know with accuracy the amount necessary to produce a given effect. The range in phosphoric-acid contents in the soils of Kentucky, as determined from many hundred analyses, varies from 0.540 to 0.061.[1] In most cases the fitness of the soil for grain-tillage is measurably proportionate to the phosphatic contents. It seems almost certain, though not yet demonstrated, that the greater part of the phosphatic matter in the soil is in the state known as insoluble and that it only becomes in small part, year by year, soluble, or, in other words, fitted for assimilation by plants. Whenever the soil

[1] Among the analyses recently made by the chemists of ahe Kentucky geological survey is one which indicates the presence of phosphoric acid in considerable quantities in the limestones of coniferous age exposed at Stewart's mill, on Lulbegrud Creek, in Clark County. This partial analysis, for which I am indebted to Mr. John R. Proctor, the present director of the Kentucky survey, is as follows: viz., —

Lime carbonate	21.380
Magnesia	3.055
Phosphoric acid	9.710
Potash	.830
Soda	.228
Silicious nodules insoluble in acids	27.580

[1] See report of Dr. Robert Peter in Reports of Geological Survey of Kentucky, new series, vol. v. 1878.

contains the quantity of lime which characterizes the better class of Kentucky soils, it is supposed, that, even if soluble phosphatic manures are applied, the superphosphate becomes again insoluble by taking up a molecule of lime. It is therefore an interesting question as to the means by which the lime phosphate enters the plants. It may be that the solution is effected through the action of the various humic acids of the soil, or it may arise from some specific change which takes place at the contact of the soil with the roots. It is evident that this point requires precise determination, for on it will depend further experiments as to the methods of applying phosphatic manures.

There is yet another point on which we need experiments. Many of our rock phosphates, especially those which are distinctly bedded, contain low percentages of phosphatic matter. Many of our lime phosphates contain crystals of apatite and calcite so intermingled that it is not possible to separate them; yet from these deposits it will be easy to produce a mixture of lime carbonate and lime phosphate containing from 10 to 20 per cent of phosphoric acid. The value of such material for manure has never been determined. If it can be used in a way which will give to the fields the full value for both the lime and the phosphorus, it will open a way for an extensive production of cheap fertilizers.

The foregoing considerations give the general results of the preliminary inquiry into phosphatic manures, of which Dr. Penrose's work forms a part. Before we go further into these studies, I much desire to have the criticism and advice of others who have considered this subject. It is with this view that I have ventured to give in the foregoing pages an account of the aim of the inquiries I have in hand. The questions are at once chemical and geological, and demand much co-operation for their solution. Much of the work of searching for the unknown phosphatic deposits of this country will necessarily have to be undertaken by local students of geology or by commercial explorers in search of such deposits. Unfortunately, the unfamiliar aspect of the various forms of phosphatic deposits will make this task under any circumstances difficult. There is no substance of equally wide diffusion among those of considerable commercial importance, which, in the present state of popular knowledge, so readily escapes detection as lime phosphate.

BOOK-REVIEWS.

Social Progress. By DANIEL GREENLEAF THOMPSON. London and New York, Longmans, Green, & Co. 8°. $2.

THIS work is an inquiry into the foundations of social life and the means and methods of progress. The first part deals with the conditions of social progress; the second, with the means of promoting it. The work contains nothing that is specially new or striking, but is rather a restatement of the general principles of free government and social improvement as viewed from the standpoint of an evolutionist. The author's style is clear and flowing, so that the book is easy and agreeable to read; and there is much in it that thinkers of all schools will agree with. Mr. Thompson begins with a discussion of liberty and law, which he declares to be inseparable. All men, he maintains, must have equal rights and equal protection under the law; but as men and classes differ in power, the maintenance of equal rights has always been difficult. In former times the difficulty arose chiefly from military ambition and priestcraft, while in our time the danger that threatens us is that of a plutocracy. The main defect in this portion of Mr. Thompson's work is its inadequate recognition of the moral element in society. He does indeed recognize it, but he gives an altogether insufficient account of it. He bases society on self-interest alone, and reduces even benevolence itself to selfish prudence. He inquires why it is that we take pleasure in promoting the good of others, and answers the question thus: "Upon investigation we cannot fail to be led to the conclusion that the foundation for this is the selfish consideration of how delightful it would be if everybody else besides ourselves were animated by the desire and purpose of helping instead of hurting his neighbor" (pp. 63, 64): in other words, we do good to others in order that they may do good to us. The second part of Mr. Thompson's treatise treats of radicalism and conservatism, of the need of frequent change in order that society may progress, and of the best way of effecting such changes. It offers many interesting remarks on the need of care in the formation of opinion, on the folly of attempting political changes before the public is ready for them, and on other matters incidental to the subject. On the whole, this part of the work, though dealing with less fundamental questions than the first part, is more satisfactory.

Scientific Religion. By LAURENCE OLIPHANT. Buffalo, Charles A. Wenborne. 8°. $2.50.

WHY the doctrine taught in this book should be called scientific we do not know, for its characteristics are all of the opposite kind. Mr. Oliphant sees, as most other men do, that the old religious views will no longer suffice, and he undertakes in these pages to furnish a substitute. He believes in communication with departed spirits, who will teach us many important truths and render us invaluable aid if we will but listen to them. He holds that "the unseen world teems with intelligences, whose action upon this one is very direct, and is governed by laws." "This," he declares, "is a fact of my own personal experience." Spirit, he maintains, is only a higher form of matter, and the spirits in the unseen world communicate with us by the "interlocking of atoms." It is sad to learn, however, that the unseen spirits are not all good, and that the bad ones exert a baneful influence upon us, some of our worst impulses being due to their "infestation." Insanity, also, is due to them; and "when, therefore, we read in the Gospels of the cures by Christ of men possessed by devils, the expression is literally accurate." It depends on us, however, whether we will be influenced by the good spirits or the bad ones; and, in order to obtain the highest favors from the spirit world, we must become "bisexual." Adam, we learn, before the fall, was bisexual, and though his feminine part was separable from the masculine, the two were still one, this being possible in the case of Adam and Eve because their atomic structure was "four-dimensional." Christ, also, was bisexual, and, in fact, came into the world to restore the bisexual principle. Such is the stuff that Mr. Oliphant offers us as a new religion, and he expects men to abandon the Christianity of the churches for this! A large part of his book is devoted to a mystical interpretation of the Bible, and the rest is mainly occupied with the doctrine of spirits. We regard the appearance of this work and others of a similar character as one of the strangest signs of the times, and as indicative of a mental aberration that is truly amazing.

German Commercial Correspondence. By JOSEPH T. DANN. London and New York, Longmans, Green, & Co. 16°. 80 cents.

THIS book is of the *multum in parvo* kind, containing a great deal in a small compass. Its author was at one time assistant master in University College School in London, and it is intended not only for the use of schools and classes, but also for self-tuition. Specimens of letters are given for translation from German into English and from English into German. Copious notes, sufficient to enable the student to understand and render every idiom, are supplied, being placed at the end of the book, so that students may learn them by heart before translation is attempted. At the end of each section, subjects for writing letters similar to those contained therein are given, by way of exercises, so as to enable students to turn the study of the section itself to account. Copious vocabularies, German-English and English-German, are appended, embodying all the words which the student cannot be expected to have acquired in an elementary training. The idioms and peculiarities of the language have received special attention, so that the student may know not only what to do, but what to avoid.

French Commercial Correspondence. By ELPHEGE JANAU. London and New York, Longmans, Green, & Co. 16°. 80 cents.

THIS and its companion, the "German Commercial Correspondence," mentioned above, are constructed on such a plan that they may be used separately or together. The substance of the letters, in French or German, forming the first part of each section, is the same, and the English letters forming the second part are identical in the two volumes. In the third part are subjects for letters,

giving the student an opportunity to turn to account the study of the preceding two parts, and to acquire a greater command over the language and more self-confidence than by the process of mere translation. Like its fellow-volume in German, this contains a copious double vocabulary.

Elements of Plane Analytic Geometry. By JOHN D. RUNKLE. Boston, Ginn & Co. 8°. $2.

THE author of this work is Walker professor of mathematics in the Massachusetts Institute of Technology at Boston, and the matter composing the first eight chapters of the book has been used by the students of that institute for some few years. The needs of the students have not been lost sight of in the preparation of the book. Though it is necessary that they should become reasonably familiar with the more elementary and fundamental parts of the subject, still the time which they can devote to it is limited. Therefore the earlier chapters are treated with somewhat more fulness than is usual in books of the kind, and particular care has been taken to illustrate and enforce all parts of the subject by a large number of numerical applications. Only the simpler problems have been selected; and an effort has been made to have the number of problems proportioned to the time which the students can profitably devote to them. The latter part of the book is based on a treatise upon conic sections by Charles Smith, M.A., of Cambridge, England, the later chapters following Mr. Smith's work quite closely. Teachers and students besides those in the Institute of Technology will find Professor Runkle's book adapted to their needs.

The Beginner's Reading Book. By EBEN H. DAVIS. Philadelphia, Lippincott. 12°. 42 cents.

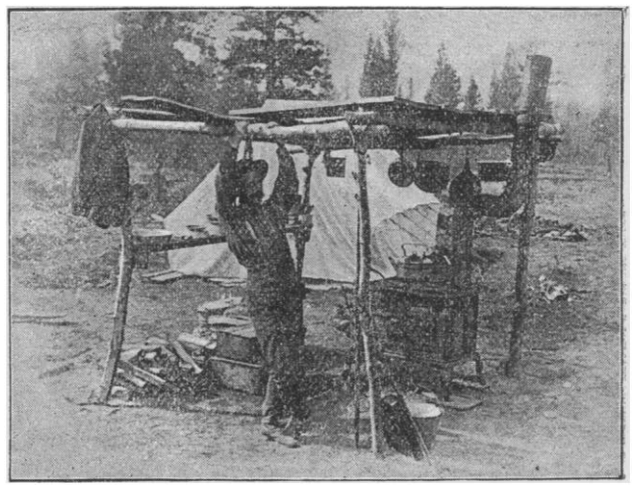
THIS little book contains a series of elementary lessons for youngest readers, with appropriate pictorial illustrations, and in these respects it does not differ essentially from other works of a similar kind. But the author has a theory about the best method of teaching children to read, and he explains his method in an introduction. He begins his instructions by talking with his pupils about the various objects provided for them, thus leading them to frame brief sentences about the objects. These sentences are then placed upon a blackboard in script letters, and the children are taught to read them; and not until some twenty weeks have been spent in this way are the pupils to take up their reading-books and begin to read print. Whether this is the best way to teach children to read, experience must decide; but it seems a roundabout process. However, there is an old saying that the shortest way across is sometimes the longest way round; and so Mr. Davis's method may, after all, be the best.

AMONG THE PUBLISHERS.

WE reproduce in this number three illustrations, "The Kitchen," "Jim," and "Canadian Grouse," from "B. C. 1887," a book of travel and adventure in British Columbia, published by Longmans, Green, & Co., and reviewed lately in these columns.

— A contest has long been waged among educators as to which is of greater practical value in education, the classics or the sciences. For many years the friends of the classics had it pretty much their own way, but of late the scientists have been putting in some strong pleas in behalf of their side of the case. The latest of these, about to be issued in book form by S. C. Griggs & Co., Chicago, is by the well-known author and scientist, Dr. Alexander Winchell, University of Michigan, and is entitled, "Shall We Teach Geology?" Few, if any, American writers are better qualified for discussing this question than Dr. Winchell. While his treatise is a special plea for teaching geology in the public schools, it is intended to cover the whole ground of contest between the sciences and the classics, and hence promises to be of great interest, not only to teachers, but to all who are interested in observing the tendencies of modern education.

— Charles Scribner's Sons have just ready "French Traits," by W. C. Brownell, an analysis of French character and French society. The method of criticism is comparative throughout, the social customs, intellectual habits, art instincts, and moral standards of the French being brought into juxtaposition with those that prevail in the United States. They have also just ready a treatise on metaphysics, by Dr. James McCosh, entitled "First and Fundamental Truths," which is regarded by the author as the copestone of what



From "B.C. 1887." *Longmans, Green, & Co.*

THE KITCHEN WINDERMERE STORE.

he has been able to do in philosophy, and in which he formulates and explains the fundamental law governing the associated mental exercises. Finally, they have a new and revised edition for 1889 of Thomas A. Janvier's "Mexican Guide."

— A. C. Armstrong & Son have just published three important works on the Asiatic continent,— "Through the Heart of Asia over the Pamir to India," by Gabriel Bonvalot, which has been translated

From "B.C. 1887." *Longmans, Green, & Co.*

JIM AND THE SORREL NAG.

from the French by C. B. Pitman, and is published in two volumes, with 250 illustrations by Albert Pepin; "The Industries of Japan," by Professor J. J. Rein of the University of Bonn, which gives an account of the agriculture, mining, forestry, arts, and commerce, from travels and researches in Japan, undertaken at the cost of the Prussian Government; and a second edition of the same author's work on "Japan, Travels and Researches," which, by verdict of the London *Spectator*, will be "the standard authority in such mat-

ters" for a long time to come. The new volume in the Book-Lovers' Library is "Foreign Visitors in England, and What They have thought of Us," which makes the ninth in this series.

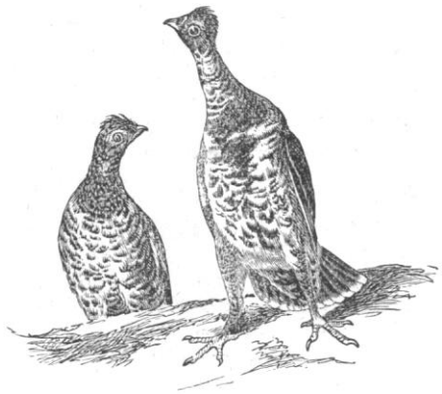
— The new *Atlantic* index is rapidly approaching completion.

— Houghton, Mifflin, & Co. have just issued Henry S. Dana's "History of Woodstock, Vermont."

— Lee & Shepard have just published "Essays, Religious, Social, Political," by David Atwood Wasson. The book includes an autobiographic sketch, and a biography of Mr. Wasson, by his friend and contemporary, O. B. Frothingham.

— "Franklin's Works," published by subscription at five dollars a volume, are now quoted at ten dollars each, or one hundred dollars for the set. Remarking on this, the *Critic* says, "What a pity it is, by the way, that the Putnams issued so small an edition! To think that only 600 out of 60,000,000 of free-born antimonopoly Americans can own a copy of Franklin's complete works!" We trust some day Messrs. Putnam will see their way clear to publish an abridged edition.

— G. P. Putnam's Sons have in preparation a translation, by Miss Ruth Putnam and Mr. Alexander Arbuthnot, of the "Histoire de la



From "B.C. 1887." *Longmans, Green, & Co.*

THE CANADIAN GROUSE (DENDRAGAPUS CANADENSIS).

Participation de la France à l'Établissement des États-Unis d'Amèrique," by Henri Doniol. The edition will probably be a limited one. They have also in press a work by Theodore Roosevelt, on the early history of our Western territory, entitled "The Winning of the West and South-west, from the Alleghenies to the Mississippi." This is expected to be complete in two volumes, the first of which will cover the period 1769–83; that is, to the close of the Revolution.

— William Wood & Co. have recently inaugurated a new and original plan for furnishing the most recent, the most advanced, and the most authoritative writings of prominent instructors and practitioners of medical science throughout the world. They have issued the first of *Wood's Medical and Surgical Monographs*, containing three articles, — "The Pedigree of Disease," by Jonathan Hutchison; "Common Diseases of the Skin," by Robert M. Simon; and "Varieties and Treatment of Bronchitis," by Dr. Ferrand. They propose to issue one of these monographs per month, covering the details of experiments and methods which have led to the latest discoveries and newest practice. The translations from foreign languages will be intrusted to experts on the subject as well as good linguists. All that is being learned and done throughout the world will thus month by month be reported in the best manner. The first issue is one of 259 pages, and this will be the average size.

— Houghton, Mifflin, & Co. will soon publish "Home Gymnastics for the Well and the Sick," containing directions how to preserve and increase health, also how to overcome conditions of ill health by simple movements of the body, adapted to all ages and both sexes, edited by Dr. E. Angerstein, superintendent of the gymnasiums of the city of Berlin, and G. Eckler, head teacher of the Royal Institution for Educating Teachers of Gymnastics, translated from the eighth German edition by Mr. Berthold Schlesinger, a well-known business-man of Boston, and amply furnished with illustrations.

— The supplement has become an important feature of *Harper's Weekly*. "American Men-of-War," by Lieut. J. D. Jerrold Kelley, U.S.N., with twenty-seven illustrations, forms the supplement to the issue of Feb. 9: that to the Feb. 16 number is devoted to an illustrated description of Omaha, Neb.

— All teachers of modern languages feel the need of varying the reading-matter used in their elementary classes. Not only do they themselves tire of going over familiar ground, but their pupils are apt to conceive a certain contempt for a language which they see represented year after year by the same two or three time-honored productions. D. C. Heath & Co. are issuing a series of texts, selected from the best writers, in inexpensive editions. To the twenty German and French texts of their list, they have just added, by purchase of C. H. Kilborn, "The Story of Ali Baba and the Forty Thieves;" "Der Zwerg Nase: Marchen von Wilhelm Hauff;" "Chamisso's Peter Schlemihl;" "Heine's Die Harzreise;" "Choix D'extraits de Daudet;" "Souvestre's Confessions d'un Ouvrier." They will add to the above this week "Jeanne D'Arc," edited by Barrère.

— Thomas L. James, postmaster-general in Garfield's cabinet, will contribute his first magazine article to the March *Scribner*, entitled "The Railway Mail Service." Thomas A. Janvier ("Ivory Black") will tell a bunch of Mexican folk-tales and superstitions collected by him during his many trips in that country. Gilberto Cano, "the best waiter at the Café Anglais," in the City of Mexico, told him many of these strange stories. The city of Treves, in Germany, founded 2004 years before Christ, and later for a century capital of the Roman Empire, will be described by Professor W. B. Scott of Princeton, who has recently made a careful study of its antiquities. Henry James will contribute the end paper, "An Animated Conversation" on international topics between Americans and Englishmen who meet in a London hotel. The paper is in dialogue form.

— In *The Home Journal* of Feb. 6 is given a selection of the poems of the late George Perry, who for many years was literary editor of that journal.

LETTERS TO THE EDITOR.

***Correspondents are requested to be as brief as possible. The writer's name is in all cases required as proof of good faith.*

Twenty copies of the number containing his communication will be furnished free to any correspondent on request.

The editor will be glad to publish any queries consonant with the character of the journal.

O'Reilly's "Greenland."

MR. PILLING'S "Bibliography of the Eskimo Language" has received a bit of undeserved criticism, which I am very glad to be able to correct. An unsigned review in the *Athenæum* (Aug. 4, 1888), which is, on the whole, quite fair, and even complimentary, finds fault with Mr. Pilling for including in his bibliography O'Reilly's "Greenland," "though that work is now generally understood to have been a literary mystification." This interested me, as I had consulted the work in question, which purports to be an account of the writer's visit to Greenland in 1817, and had inserted the title in some bibliographical work of my own, not yet published.

The fact of its being a "literary mystification" did not appear to be "generally understood" in America, whatever might be the case in England. On the other hand, there appear to me to be strong internal evidence that the writer had made a visit to Greenland, and that the undoubted rubbish with which the book is filled was merely due to the ignorance and conceit of the author.

I accordingly put myself in communication with the editor of the *Athenæum*, and after a while received, in reply to my inquiries as to the history of the book, a memorandum from the reviewer, — who, however, declined to reveal his name, — as follows: —

"The person who wrote 'O'Reilly's' work on Greenland is not known. The author had probably made a voyage on board a whaler, but the greater part of the volume is simply imagination. In the *Quarterly Review* for 1818, p. 209, it is eviscerated, and the small portion which is 'not absolute nonsense' pronounced 'either fiction or downright falsehood.'"

This seemed conclusive, but I naturally turned for further corroboration to the passage in the *Quarterly Review* referred to.

Judge of my surprise when I found, on the preceding page (p. 208), the following passage, which the *Athenæum* reviewer, had evidently neglected to read when he declared that the person who wrote the book was not known: —

"Our first impression, on taking up the volume, was, that, as the subject of the Arctic regions had become one of the fashionable topics of the day . . . some hanger-on of Paternoster Row had contrived, with the help of Egede, Fabricius, and the interminable Cyclopædia of Dr. Rees, to hash up a fictitious voyage to Davis's Strait, in order to gratify the eager appetite of the public, and at the same time to 'put money in his purse.' Recollecting, however, that the log-book of the ship 'Thomas,' of Hull, in which this voyage is stated to have been made, was within our reach, we turned to it, and found that *Bernard O'Reilly, Esq., was not, as we suspected, a phantom conjured up for the occasion, but that there actually was a person of this name, in the capacity of surgeon, on board that ship*" [the Italics are mine].

The process of "evisceration" referred to by the *Athenæum* reviewer then begins with great ferocity — too great, it seems to me, even for such a ridiculous book as it is. This, however, only proves, what is easily seen from reading the book, that it is quite worthless from a scientific point of view, and evidently the work of what we should call a "crank" nowadays, not that it is not the work of the man whose name appears on the titlepage.

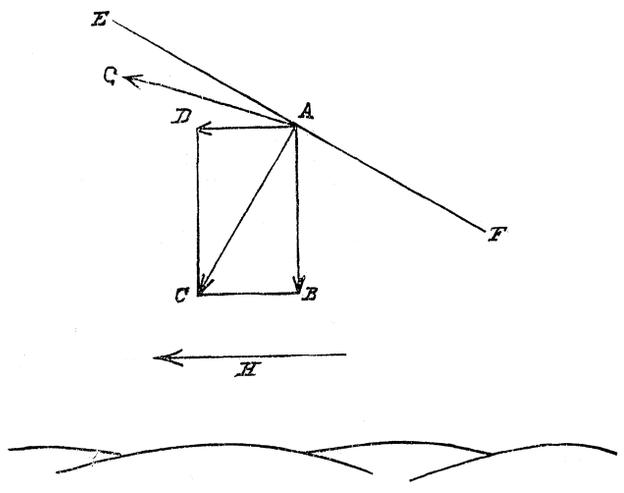
If the *Athenæum* reviewer has no further evidence to submit in regard to the authorship of the book, I do not see how we can doubt that the book is genuine, even though it is not authentic (which is quite another matter), and that it was perfectly proper to insert the title in a bibliography of such extended scope as Mr. Pilling's work. In fact, it would have been a mistake for Mr. Pilling to omit the book from his list, in spite of all its glaring absurdities.

JOHN MURDOCH.

Smithsonian Institution, Feb. 18.

The Soaring of Birds.

OWING to the remoteness of my present situation, I have but just seen the query of Mr. Kent. The point which he makes is a good one. I see also that I made a slight misstatement in my previous article. In the first place, as before remarked, we have the force AB due to the weight of the bird, and the force AD due to the



excess of velocity of the wind over the velocity of the bird. These two forces may be combined into the resultant AC. This resultant is resisted by the force CA, due to the resistance of the air acting on the wings of the bird as he wheels in circles about the point A. The force CA is therefore proportional to a function of the velocity with which the bird moves in describing these circles. The greater the velocity of the bird, the greater the force. Now, this velocity which he is capable of attaining with regard to the wind is dependent solely on the absolute velocity of the wind with regard to the earth, and can never be more than twice as great; i.e., when he is moving with the velocity of the wind and in the opposite direction.

Now let the velocity of the wind be x, and the excess of its velocity over the mean linear velocity of the bird (with respect to the earth) in the same direction as the wind be a, then the mean linear velocity of the bird with regard to the earth will be $x-a$. We will suppose that the velocity of the wind is such that $CA=AC$: the bird will therefore continue to revolve about the point A, which will consequently be its mean position. It must, of course, be remembered, that, while these forces are in equilibrium, the bird is slowly drifting over the earth's surface in the same direction as the wind. Its mean position would therefore describe a horizontal line with respect to the earth.

Now suppose the velocity of the wind (x) to increase, while its excess over that of the bird (a) remains the same: AC will therefore remain constant. But the velocity of the bird with regard to the earth ($x-a$), and also his absolute velocity with respect to the surrounding air, have increased, and therefore CA has increased also. Accordingly, the bird will be carried above and to the right of the point A. In the mean time the bird is drifting rapidly towards the left, in the direction of the wind: he will therefore describe a path lying in the same general direction as the line AG, *Q. E. D.*

W. H. PICKERING.

Los Angeles, Cal., Feb. 11.

A RECENT number of *Science* (xii. p. 267) gives an account of a paper by Mr. G. K. Gilbert, containing a theory of the soaring of birds, which traces this phenomenon to the advantage gained by the bird in gliding to and fro between contiguous horizontal layers of a horizontal wind, moving at different rates. The theory presented is said to have been anticipated by Lord Rayleigh (*Nature*, xxvii. p. 534); but it seems to me to rest upon what is, apparently at any rate, quite a different assumption from that which Lord Rayleigh made.

Mr. Gilbert imagines a bird gliding to windward in the lower of two contiguous layers, and traces the changes which his relative velocity will undergo if he first pass into the upper layer, then turn in it, then move to leeward, passing into the lower layer, and finally complete a cycle by turning to windward. He concludes, that, after the completion of the cycle, the bird's velocity will have increased by twice the velocity of the upper layer relative to the lower, frictional resistance being left out of account. This result he obtains by assuming, that, after turning, the bird's velocity, relative to the medium in which he turns, will be the same as before; in other words, that during the turn his velocity relative to the earth will change by an amount equal to twice the velocity, relative to the earth, of the medium in which the turn is made; the change being an increment in the turn to windward, and a decrement in the turn to leeward. Of course, in accounting for the phenomenon of soaring, some assumption must be made as to the bird's power of regulating the magnitude and direction of the force exerted upon him by the wind. But it should be a reasonable one, and, if not evidently so, should be justified. Mr. Gilbert's assumption does not seem evidently reasonable, and yet he does not even refer to its having been made.

In another recent number of *Science* (xiii. p. 31), Professor Pickering has shown that in a uniform horizontal wind the phenomenon of soaring is quite consistent with the law of the conservation of energy, provided frictional resistance is not too great, but he does not show how it may be accomplished. Lord Rayleigh, on the other hand, has stated that a uniform horizontal wind certainly cannot help us to explain this phenomenon. With so emphatic a statement from so high an authority, one is fearful of rushing in where angels fear to tread in attempting an explanation on this hypothesis. Nevertheless I venture to submit to your readers the following considerations, showing, I think, how soaring may occur in a horizontal wind which has no differential motion.

The force exerted by a horizontal wind on a bird may clearly be inclined upwards; for the wind, striking the lower surface of the wing, is deflected downwards, and must therefore have been acted upon by the wing with a downward force. The wind must therefore have exerted on the wing an upward force. What the exact direction and magnitude of this upward force will be, will depend upon the velocity of the wind relative to the bird, the wing area, and the ingenuity of the bird in adjusting its wings. With a strong wind and a wing area large relatively to the mass of the bird, it

may readily be large enough to have a vertical component equal to the bird's weight, in which case the resultant force on the bird may be horizontal.

Let us suppose, now, that a bird is at any instant moving horizontally, in the same direction as the wind, and with a small velocity relative to the earth. Since the resultant force on him may be horizontal, he may continue to move horizontally with increasing speed. As his speed increases, the velocity of the wind relative to him diminishes, and therefore also, probably, the upward force exerted on him by the wind. Although, therefore, the resultant force on the bird may have been initially horizontal, it will not remain so even for a short time. But it may remain for some time very nearly horizontal; for, as the magnitude of the relative velocity diminishes, its inclination to the normal to the plane of the wings will diminish also. During that time the bird will move slightly downwards, and his velocity will increase. When his velocity has become so great, and therefore the velocity of the wind relative to him so small, that the resultant force on him begins to have a direction differing markedly from the horizontal, let the bird wheel and steer upwards to windward. Let us suppose that in wheeling he maintains his velocity relative to the earth as well as his elevation. Then, starting upwards with a considerable velocity, he will clearly be able to rise through a certain height before his velocity has been reduced to its initial value. Let him then wheel again, and he will now be in a position to repeat the cycle with the same starting conditions as before. Whether soaring has been accomplished or not, will depend on whether or not the height gained when moving to windward is or is not greater than that lost in moving to leeward.

To determine this, consider first the downward part of the cycle. Let W_1 be the mean vertical component, and W_2 the mean horizontal component, of the force exerted by the wind on the bird's wings. Let R be the mean resistance to the relative motion of bird and air (due to friction, etc.), which in this case helps the bird. Let w be the weight of the bird, h the height through which he falls, and d the horizontal distance he traverses. Then the work done on the bird by the vertical and horizontal forces will be $(w - W_1)h$ and $(R + W_2)d$ respectively (we may treat R as a horizontal force, because the path is nearly horizontal). Let H be the energy expended immediately or ultimately in the production of heat. Then the kinetic energy gained by the bird on the downward motion will be —

$$(w - W_1)h + (R + W_2)d - H.$$

During the upward motion against the wind, the mean velocity of the wind relative to the bird will be much greater than during the downward motion with the wind; but while the direction of the relative velocity during the downward motion was upward, during the upward motion it is downward. It seems reasonable, therefore, to suppose that the upward force exerted by the wind may be made by the bird the same as before, and may have, therefore, the same components, W_1 and W_2. Let R' be the mean resistance of the air due to friction, etc. R', in this case, impedes the motion of the bird. Let w, as before, be the bird's weight; and let h' be the height through which he rises, and d' the distance traversed horizontally. Then the work done by the bird against the forces acting on him will be —

$$(w - W_1)h' + (R' + W_2)d'.$$

If the bird wheels when the energy expended on the upward motion is just equal to that gained on the downward motion, he will be ready to begin his second cycle under the same starting conditions as his first, and we shall have, for determining the height to which he has risen, the equation —

$$(w - W_1)h + (R + W_2)d - H = (w - W_1)h' + (R' + W_2)d',$$

from which it follows that the gain of elevation

$$h' - h = \frac{Rd - R'd' + W_2(d - d') - H}{w - W_1}.$$

Since during the upward motion against the wind the mean value of the velocity of the air relative to the bird is greater than in the downward motion, R' will be greater than R. But the bird can so steer his course as to give his path a greater inclination to the horizon than his downward path had: hence d' may be made smaller than d; and thus $Rd - R'd'$ may, by good steering, be made positive. Also, d' being less than d, $W_2(d - d')$ will be positive. If these two quantities together are greater than H, $h' - h$ will be positive; and if, finally, the increase of energy represented by the elevation $h' - h$ is greater than the inevitable waste during the turns, the bird will have increased his elevation during the cycle.

It seems to me possible, therefore, for a bird to soar in a uniform horizontal wind; because, by falling slowly in the motion to leeward, he allows the wind to do a large amount of work on him, and, by rising rapidly in moving to windward, he may regain his former level without having to do so much work against the wind. If it is possible, the bird's path must clearly be a spiral about a line rising in the direction of the wind, not about a vertical line; and this agrees exactly with observed fact. J. G. MACGREGOR.

Dalhousie College, Halifax, N.S., Feb. 5.

Some Habits of the Omahas.

IN the article entitled "Some Habits of the Omahas," on p. 60 of *Science* for Jan. 25, was a slip of the pen, which I wish to correct. Both Omahas and Ponkas, who speak the same dialect, call the wild honey "bee-dung." The term "bee-gum" was given me in 1872 by a Ponka, my interpreter, who stated that it was not the old name. My Omaha informant, Samuel Fremont, does not wish incorrect statements credited to him. J. OWEN DORSEY.

Takoma Park, D.C., Feb. 13.

Sawdust Explosion.

I ENCLOSE you a cutting from the Ottawa *Journal* in reference to what is called a "sawdust explosion," as it is a somewhat unique phenomenon. Last winter one occurred in the Ottawa River opposite this city, near the place referred to in this article, which broke up the thick ice over a large space. The river-channel is deep, but it is filled with a great accumulation of sawdust from the large mills just above. This sawdust generates immense quantities of marsh-gas, and once in a while something seems to start it up suddenly in large volumes. These striking the under side of the ice with great force, burst it up in the manner here described. This is why they are called "explosions." The gas is never ignited.

"Mr. J. de St. Denis Lemoine, sergeant-at-arms of the Senate, was blown up in a sawdust explosion on the Ottawa River, Saturday, Feb. 9, 1889, at midnight. He escaped with a wetting, and will not snowshoe to Gatineau Point again. It was a jolly party of gentlemen who left the city Saturday evening for a tramp on the ice-bound Ottawa. It included Messrs. Riddington, Lemoine, R. Fleming, J. Travers Lewis, J. W. Pugsley, Charles Elliott, Laurence Taylor, W. Middleton, Bogert, G. A. Henderson, and some others.

"The snowshoers headed direct to Gatineau Point, where an enjoyable time was spent. They started for home shortly before midnight. Mr. Riddington led the way, the snowshoers following in Indian file at a distance of about ten feet apart. The leader cautiously picked his way, because an ominous crackle here and there gave warning of proximity to cold waters running a few inches beneath.

"Matters went well for a time, until, some little distance below the Rideau Falls, suddenly the snowshoers were startled by a terrific explosion. An instant later they saw Mr. Lemoine hurled in the air, and as suddenly fall back into a mass of broken ice. It was only the work of a moment to grasp the sash of Mr. Lemoine and haul him on to the firm ice, not much the worse for his partial wetting. There would have been a funeral had the sergeant-at-arms been in the middle of the explosion.

"Mr. J. Travers Lewis had a narrow escape. Fortunately he stopped for a moment to fix his snowshoe-strings, and, had he continued in the footsteps of Mr. Lemoine, would also likely have experienced a sad fate.

"The snowshoers say that in their opinion the sawdust question has been solved." ROBERT BELL.

Ottawa, Can., Feb. 13.